EOTA

TECHNICAL REPORT

A factory made structural anchor for attaching personal fall protection equipment, designed to be permanently fully bonded to a multilayered modified bitumen roof waterproofing system provided with polyester reinforcement to a maximum roof slope of 15°, without perforating the roof waterproofing system

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TECHNICAL REPORT

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A FACTORY MADE STRUCTURAL ANCHOR FOR ATTACHING PERSONAL FALL PROTECTION EQUIPMENT, DESIGNED TO BE PERMANENTLY FULLY BONDED TO A MULTILAYERED MODIFIED BITUMEN ROOF WATERPROOFING SYSTEM PROVIDED WITH POLYESTER REINFORCEMENT TO A MAXIMUM ROOF SLOPE OF 15°, WITHOUT PERFORATING THE ROOF WATERPROOFING SYSTEM

Testing procedures for:

I. **STRENGTH OF THE ASSEMBLY OF THE STEEL COMPONENTS OF THE STRUCTURAL ANCHOR**
II. **FALL ARREST SYSTEM**
III. **RESTRAINT SYSTEM**

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Foreword

EOTA Technical Reports are developed as supporting reference documents to European Technical Approval Guidelines and can also be applicable to a Common Understanding of Assessment Procedures, an EOTA Comprehension Document or an European Technical Approval, as far as reference is made therein.

EOTA Technical Reports go into detail in some aspects and express the common understanding of existing knowledge and experience of the EOTA bodies at a particular point in time.

Where knowledge and experience is developing, especially through approval work, such reports can be amended and supplemented.
When this happens, the effect of the changes upon the European Technical Approval Guidelines will be laid down in the relevant comprehension documents, unless the European Technical Approval Guideline is revised.

This EOTA Technical Report has been prepared by the approval body "SGS INTRON Certificatie B.V." to define testing procedures in support of the CUAP 06.01/24: "A factory made structural anchor for attaching personal fall protection equipment, designed to be permanently fully bonded to a multilayered modified bitumen roof waterproofing system provided with a polyester reinforcement to a maximum roof slope of 15°, without perforating the roof waterproofing system".

INTRODUCTION

This EOTA Technical Report is dealing with test procedures for a structural anchor as indicated in the figure 1 to be used in a personal fall protection system for fall arrest as defined in clause 3.2.1.4 of EN 363 and/or for restraint as defined in clause 3.2.1.1 of EN 363.
NOTE*: A personal fall protection system is an assembly of an anchor point and a Personal Protective Equipment against falls from a height (see EN 363 "Introduction")*

In the Annex **A** to this EOTA Technical Report a justification is given for the chosen roofing construction, the insulation material, the choice of the types of roofing membrane and the loading condition for "bitumen" products.

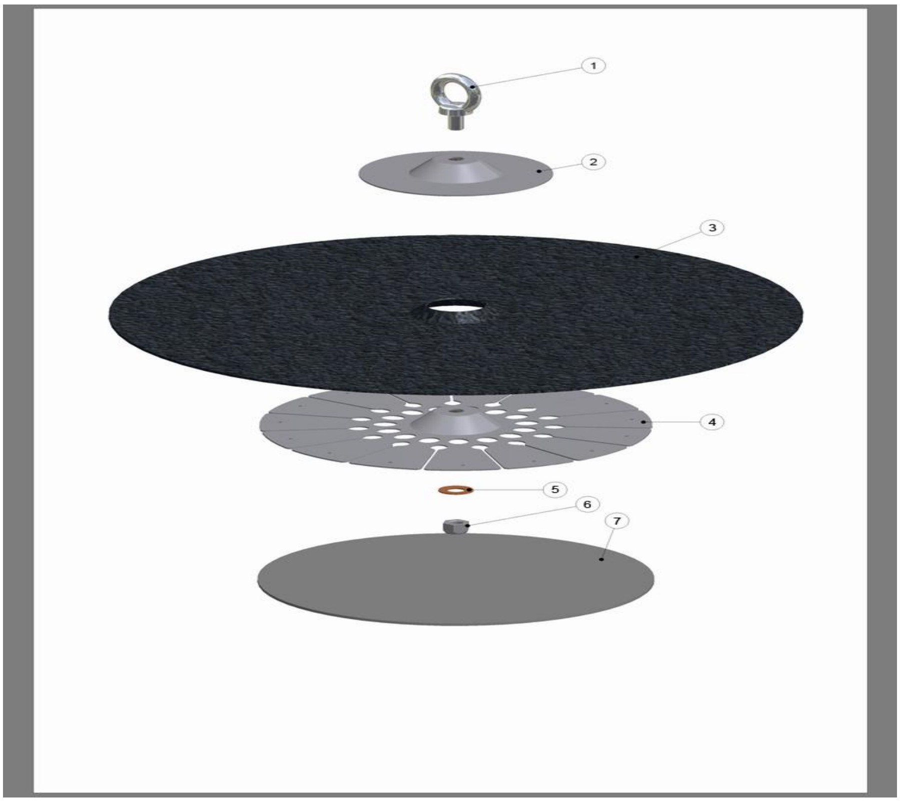


Figure 1 – Principle build-up of the structural anchor

Key:

1	stainless steel anchor point
2	stainless steel upper plate
3	flexible reinforced bitumen upper sheet
4	stainless steel lower plate
5 and 6	stainless steel spring washer and lock nut
7	flexible reinforced bitumen lower sheet

I STRENGTH OF THE ASSEMBLY OF THE STEEL COMPONENTS OF THE STRUCTURAL ANCHOR

I.1 PRINCIPLE

A test specimen consisting of assembly of the steel components is installed in a test apparatus.
On this assembly of steel components a deformation test, a dynamic testing followed by a static testing shall be performed.

I.2 TEST SPECIMEN

The test specimen shall be the assembly of the steel components, including the anchor point (see figure 1).

I.3 APPARATUS

The test apparatus for the deformation test and static test shall be to EN 364 clauses 4.1 and 4.2.
The test apparatus for the dynamic test shall be conforming to EN 795 clauses 5.2.2.1 and 5.2.2.2.
The test lanyard shall be conforming to EN 795 clause 5.2.1. A new test lanyard shall be used for each dynamic drop test.
The connecting line between the test lanyard and the anchor device shall be made of steel wire cable 8 mm diameter of a 7 x 19 construction and be fitted with swaged eyelet connections.

I.4 TEST PROCEDURE

I.4.1 General

The test specimen shall be installed in or on the test apparatus, as appropriate, in accordance with the instructions supplied by the manufacturer, where relevant using a clamping fixing selected by the manufacturer.

Where the information provided by the manufacturer permits loading in more than one direction (e.g. in tension and in shear) the test specimen shall be tested in each critical direction.

The test shall be performed at a temperature of (20 ± 5) °C.

I.4.2 Deformation test

Install the static strength apparatus to apply the test force in the direction or directions in use in service and submit the test specimen to a static test force equal to 0,7 kN for each permissible user for (1 +0,25/- 0,0) minutes.
Remove the test force, observe and record the permanent deformation.

I.4.3 Dynamic strength test

The test procedure shall be in accordance with EN 795 clause 5.3.3

Release the rigid test mass and observe and record whether the rigid test mass is arrested. Also record the peak force at the anchor point.

I.4.4 Static strength test

Install the assembly in or on the static test apparatus specified in I.3.
Apply in each critical direction of use permitted by the information supplied by the manufacturer a static test force equal to twice the maximum peak force recorded with a minimum of 12 kN, in the direction in the dynamic strength test according I.4.3.
Hold the static test force for (3,0 ± 0,25) minutes, and observe whether the assembly holds the force.

II FALL ARREST SYSTEM

II.1 TEST PROCEDURE

For the assessment of the structural anchor in case to be used for a fall arrest system the following test procedure shall be followed.

1. **Small Scale testing**
   This test is performed on a small test specimen of the complete structural anchor adhered to the top layer of the multilayered modified bitumen roof waterproofing system under new and aged conditions.

2. **Behaviour at low temperature**
   This test is performed on a small test specimen of the complete structural anchor adhered to the top layer of the multilayered modified bitumen roof waterproofing system. This test is performed at a defined low temperature to assess the behaviour of structural anchor on the multilayered bitumen roof waterproofing system.

3. **Full Scale testing**
   This test is performed on a large test specimen using the combination of structural anchor and the multilayered modified bitumen roofing membrane. This combination shall be used for a complete roof build-up, loose laid and mechanically fastened, including a joint (overlap) and an insulation material with low compression strength. The full scale testing shall be performed at high temperature.

In table II.1 a testing scheme is given for the three different test procedures

Table II.1 – Testing scheme

		Small scale	Full scale
1	Unaged roofing membrane	**X**	
2	Aging of the roofing membrane before the anchor is adhered	**X**	
3	Aging of the structural anchor in combination with the roofing membrane	**X**	
4	Behaviour at low temperature	**X**	
5	Fastening of the roofing membrane		**L + MF**
6	High Temperature at testing		**L + MF**
7	Peel resistance of the joints		**L + MF**
L = Loose laid roofing membrane **MF** = Mechanically Fastened roofing membrane			

NOTE 1: *The chosen roofing construction of loose laid and ballasted, and mechanically fastened flexible roof waterproofing systems is also covering fully and partially bonded roofing systems (see Annex A.1).*
NOTE 2: *In the full scale testing an insulation material with a low compression strength is considered as the most critical (see Annex A.2).*

II.2 SMALL SCALE TESTING

II.2.1 PRINCIPLE

The Small Scale testing procedure is used for the following purposes.

- To determine the change in static load strength to failure on the combination of the structural anchor and the thermal aged multilayered modified bitumen roof waterproofing system;
- To determine the change in static load strength to failure on the on the combination of the thermal aged structural anchor and the thermal aged multilayered bitumen roof waterproofing system.

NOTE: *Compared to dynamic load testing, the static load testing is considered the most critical test for the application with "bitumen" products* (*see Annex A.3).*

II.2.2 TEST SPECIMEN

The test specimen consists of a top layer of a multilayered APP modified bitumen roof waterproofing system on which the structural anchor is applied.

The size of the test specimen shall be at least (1 m x 1 m).

On the top layer the structural anchor shall be adhered following the instructions supplied by the manufacturer.

The number of test pieces shall be ten (10) for the static testing.

II.2.3 APPARATUS

The test apparatus for the static test shall be conforming to EN 364 clauses 4.1 and 4.2.

II.2.4 TEST PROCEDURE

II.2.4.1 General

The general test conditions are.

- The testing shall be performed at a temperature of (20 ± 5) ° C;
- The test specimen shall be installed in or on the test apparatus, as appropriate, in accordance with information supplied by the manufacturer, where relevant using a clamping fixing selected by the manufacturer.
- Where the information provided by the manufacturer permits loading in more than one direction (e.g. in tension and in shear) the test specimen shall be tested in each critical direction.

II.2.4.2 Static strength test

Install the test specimen in or on the static test apparatus specified in II.2.3. Apply in each critical direction of use permitted by the information supplied by the manufacturer a test force starting at 12 kN and increasing that force with a value between 0,20 kN/sec and 0,25 kN/sec until failure.

Note per test specimen the maximum force, F_s, in kN.

Calculate the arithmetic mean maximum force $F_{s,m}$ in KN of the ten test pieces by deleting the lowest and the highest obtained values.

II.2.4.3 Thermal ageing procedure

II.2.4.3.1 Thermal ageing of the multilayered APP modified bitumen roof waterproofing membrane

The top layer of the multilayered APP modified bitumen roof waterproofing system shall be thermal aged at a temperature of 70 °C for a time period of 12 weeks in accordance with the procedures as detailed in EN 1296.

NOTE: *The time period of 12 weeks for the thermal ageing is derived from clause 5.2.19.1 of EN 13707.*

II.2.4.3.2 Thermal ageing of the combination structural anchor and the multilayered APP modified bitumen roof waterproofing membrane

Adhere on the top layer of the multilayered APP modified bitumen roof waterproofing system the structural anchor following the instructions supplied by the manufacturer.

The combination structural anchor/top layer of the roof waterproofing system shall be thermal aged at a temperature of 70 °C for a time period of 12 weeks in accordance with the procedures detailed in EN 1296.

NOTE: *The time period of 12 weeks for the thermal ageing is derived from clause 5.2.19.1 of EN 13707.*

II.2.4.4 Determination of the change in static force after thermal ageing

II.2.4.4.1 Change in static force after thermal ageing of the multilayered APP modified bitumen roof waterproofing membrane

Adhere on the aged top layer of the multilayered APP modified bitumen roof waterproofing system, according II.2.4.3.1 the structural anchor following the instructions supplied by the manufacturer.

Perform on the test specimen a static test in accordance with the procedures detailed in II.2.4.2 until failure.

Note per test specimen the maximum static force $\boldsymbol{F}_{\mathbf{s,a1}}$ in kN.

Calculate the arithmetic mean maximum force $\boldsymbol{F}_{\mathbf{s,a1,m}}$ in kN of the ten test pieces by deleting the lowest and the highest obtained values.

Determine the change in static force in percentage, $\boldsymbol{\Delta}_{\mathbf{s,1}}$, using formula (1)

$$\boldsymbol{\Delta}_{\mathbf{s,1}} = \frac{F_{\mathrm{s,m}} - F_{\mathrm{s,a1,m}}}{F_{\mathrm{s,m}}} \times 100 \qquad (1)$$

Whereby,

$\Delta_{s,1}$ = the change in maximum static force of the unaged combination structural anchor/ top layer of the roofing system and the maximum static force of the combination structural anchor/ aged top layer of the roofing system, in percentage;

$F_{s,m}$ = the maximum static force of the unaged combination structural anchor/ aged top layer of the roofing system, in kN;

$F_{s,a1.m}$ = the maximum static force of the combination structural anchor/ aged top layer of the roofing system, in kN.

II.2.4.4.2 Change in static force after ageing of the combination structural anchor and the multilayered APP modified bitumen roof waterproofing membrane

Perform on the test specimen in accordance with II.2.4.3.2 a static test in accordance with the procedures detailed in II.2.4.2 until failure.

Record per test specimen the maximum static force $\boldsymbol{F}_{\mathbf{s,a2}}$ in kN.

Calculate the arithmetic mean maximum force, $\boldsymbol{F_{s,a2,m}}$, in kN of the ten test pieces by deleting the lowest and the highest obtained values.

Determine the change in static force in percentage, $\Delta_{s,2}$, using formula (2)

$$\boldsymbol{\Delta_{s,2}} = \frac{F_{s,m} - F_{s,a2,m}}{F_{s,m}} \times 100 \qquad (2)$$

Whereby,

$\Delta_{s,2}$ = the change in maximum static force of the unaged combination structural anchor/top layer of the roofing system and the maximum static force of the aged combination structural anchor/top layer of the roofing system, in percentage;

$F_{s,m}$ = the maximum static force of the unaged combination structural anchor/top layer of the roofing system, in kN;

$F_{s,a2,m}$ = the maximum static force of the aged combination of the structural anchor/top layer if the roofing system, in kN.

II.3 BEHAVIOUR AT LOW TEMPERATURE

II.3.1 PRINCIPLE

To assess the behaviour of the combination structural anchor and the multilayered APP modified bitumen roof waterproofing system at low temperature a small scale dynamic strength test is performed (see Annex A.4).

II.3.2 TEST SPECIMEN

The test specimen shall be conforming to clause II.2.2.

The number of test specimen shall be three for the dynamic testing.

II.3.3 APPARATUS

The test apparatus for the dynamic test shall be conforming to EN 795 clauses 5.2.2.1 and 5.2.2.2.

When necessary, use a connecting line between the test lanyard and the load cell attached to the anchor point made of a steel wire cable 8 mm diameter of a 7 x 19 construction and fitted with swaged eyelet terminations.

Determine the free fall distance of the rigid test mass (see EN 795 clause 5.2.1.4) required to generate a fall arrest load of (12 +0,5/0) kN in the dynamic strength test.

The cooling box shall be capable of containing a test specimen with a size according II.2.2 and capable to maintain the temperature up to (- 10 ± 2) °C, (- 20 ± 2) °C or (- 30 ± 2) °C, depending on the chosen low temperature (TL_{FA}) category.

NOTE: *This dynamic load is higher than the dynamic load conforming to EN 795 (see Annex A.5).*

II.3.4 TEST PROCEDURE

II.3.4.1 General

The general test conditions are.

- The testing shall be performed at a temperature of (TL_{FA} ± 2) °C. The temperature TL_{FA} shall be chosen from the following low temperature categories being -10 °C (moderate low temperature) or -20 °C (severe low temperature) or -30 °C (extreme low temperature) and shall be indicated in the ETA.
- The test specimen shall be installed in or on the test apparatus, as appropriate, where relevant using a clamping fixing.
- Where the information provided by the manufacturer permits loading in more than one direction (e.g. in tension and in shear) the test specimen shall be tested in each critical direction.

NOTE 1: *The categorisation of the low temperature TL is derived from Table 6(a) of ETAG 005 Part 1.*
NOTE 2: *The category TL_{FA} -30 °C (extreme low temperature) shall only be taken into account when declared by the Member States (see CPD – art.3.2).*

II.3.4.2 Dynamic strength test

The dynamic strength shall be determined with the following procedure.

- Attach a load cell to the anchor point.
- Attach one end of the test lanyard to the rigid test mass by means of a connector.
- Attach the other end of the test lanyard directly to the load cell by means of a connector, or when necessary, attach a connecting line between the other end of the test lanyard and the load cell by means of a connector at both ends.
- Attach a quick release device to the rigid test mass.
- Move the rigid test mass downwards until the test lanyard holds the mass.
- Raise then the rigid test mass to the free fall distance as determined in II.3.3 and hold it at a maximum of 300 mm horizontally from the anchor point or pulley.
- Release the rigid mass and observe and record whether the rigid mass is arrested and is held clear of the ground.

II.4 FULL SCALE TESTING

II.4.1 PRINCIPLE

The full scale dynamic and static testing is performed at high temperature on a large test specimen of a complete roof build-up using the combination of the structural anchor adhered to the multilayered SBS modified bitumen roof waterproofing system as determined at the small scale testing.
The roof build-up shall be a loose laid or mechanically fastened multi-layered SBS modified bitumen roof waterproofing system, both including a joint (overlap) and an insulation material with low compression strength.

NOTE: *In the roof construction the ballast layer is not considered, because the results of the loose laid roof waterproofing system covers also the roof construction with a total bonded or partial bonded roofing system. For further justification of the choices made on the roof construction for full scale testing see Annex A.*

II.4.2 TEST SPECIMEN

The test specimen shall be a roof build-up with a size of at least (2,8 m x 2,8 m).

II.4.2.1 Roof with a loose laid multilayered SBS modified bitumen roof waterproofing system

The roof shall be build-up as follows.

- Wooden deck, constructed from multi-ply board with a thickness of 18 mm;
- A thermal insulation board with a low compression strength, being a board of mineral wool class CP4 according EN 13162, with a thickness of 100 mm;
- A multilayered bitumen roof waterproofing system consisting of :
    - A loose laid sub layer of glass fleece reinforced bitumen waterproofing membrane;
    - A fully bonded top layer of the roof waterproofing membrane following the results of the unaged static strength test on the small scale testing according II.2.4.2.
- A structural anchor.

II.4.2.2 Roof with a mechanically fastened multilayered SBS modified bitumen roof waterproofing system

The roof shall be build-up as follows.

- Steel deck, constructed from profiled steel sheets with a nominal thickness of 0,75 mm;
- A thermal insulation board with a low compression strength, being a board of mineral wool class CP4 according EN 13162, with a thickness of 100 mm;
- A multilayered bitumen roof waterproofing system, consisting of:
    - A sub layer of polyester reinforced bitumen roof waterproofing membrane, mechanically fastened with 6 fasteners per m^2 ;
    - A fully bonded top layer of the SBS modified bitumen roof waterproofing membrane following the results of the unaged static strength test on the small scale testing according II.2.4.2.

- A structural anchor.

II.4.2.3 Joints

To assess the influence of the joints and the position of the structural anchor on the performance of the "installed" structural anchor, three standard specimen types are defined. Details are given in figure II.1 and figure II.2

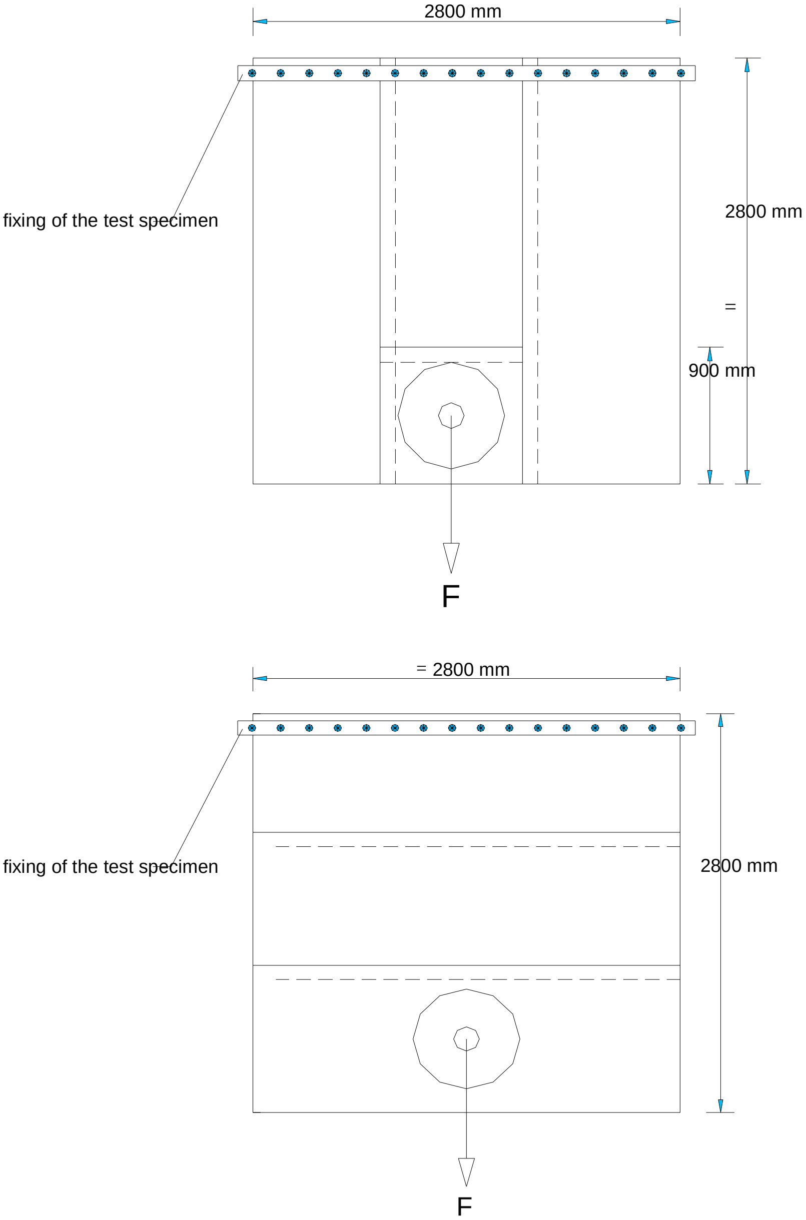
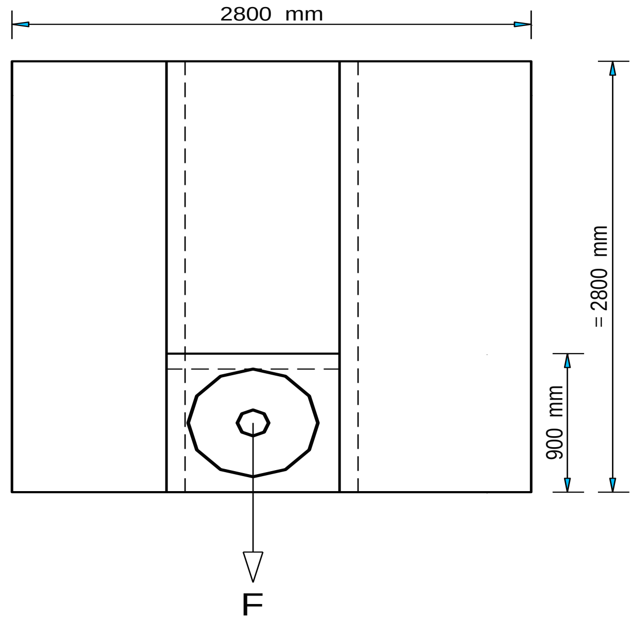


Figure II.1- Position of the joints at a loose laid system



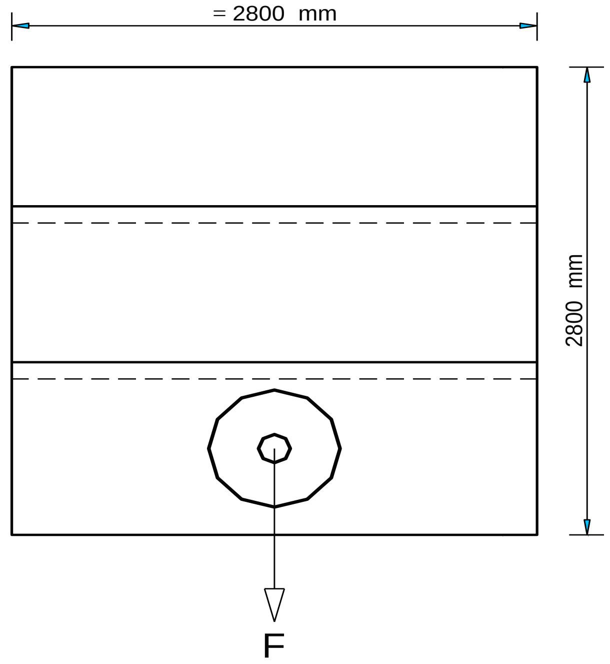


Figure II.2 – Position of the joints at a mechanically fastened systems

The shear resistance of the joint shall be determined in accordance with EN 12317-1 and shall not be lower than 500 N/50 mm.

II.4.3 APPARATUS

The test apparatus for the static test shall be conforming to EN 364 clauses 4.1 and 4.2.
The test apparatus for the dynamic test shall be conforming to EN 795 clauses 5.2.2.1 and 5.2.2.2.

The test lanyard shall be conforming to EN 795 clause 5.2.1.

When necessary, use a connecting line between the test lanyard and the load cell attached to the anchor point made of a steel wire cable 8 mm diameter of a 7 x 19 construction and fitted with swaged eyelet terminations.

Determine the free fall distance of the rigid test mass (see EN 795 clause 5.2.1.4) required to generate a fall arrest load of (12 +0,5/0) kN in the dynamic strength test.

NOTE: *This dynamic load is higher than the dynamic load conforming to EN 795 (see Annex A.5).*

A thermometer, capable of measuring the black standard temperature (BST), shall be conforming to ISO/DIS 4892-1

II.4.4 TEST PROCEDURE

II.4.4.1 General

The general criteria for the testing are the following.

- The testing shall be performed at (T_{FA} ± 5) °C.
  The temperature TH_{FA} (high temperature at fall arrest) shall be indicated in the ETA.
- The test specimen shall be installed in or on the test apparatus, as appropriate, where relevant using a clamping fixing.
- Where the information provided by the manufacturer permits loading in more than one direction (e.g. in tension and in shear) the test specimen shall be tested in each critical direction.

II.4.4.2 Dynamic strength test

The dynamic strength shall be determined in accordance with the test procedure as detailed in EN 795 clause 5.3.3.

- Attach a load cell to the anchor point.
- Attach one end of the test lanyard to the rigid test mass by means of a connector.
- Attach the other end of the test lanyard directly to the load cell by means of a connector, or when necessary, attach a connecting line between the other end of the test lanyard and the load cell by means of a connector at both ends.
- Attach a quick release device to the rigid test mass.
- Move the rigid test mass downwards until the test lanyard holds the mass.
- Raise then the rigid test mass to the free fall distance as determined in II.4.3 and hold it at a maximum of 300 mm horizontally from the anchor point or pulley.
  Release the rigid mass and observe and record whether the rigid mass is arrested and is held clear of the ground.

II.4.4.2.3 Dynamic Force

The dynamic test force $\mathbf{F_{FA,d}}$ of 12 kN has been derived from the following formula (3).

$$\mathbf{F_{FA,d}} = F \times \gamma_{Q,1} \times \gamma_M \qquad (3)$$

Whereby,
$F_{FA,d}$ = the dynamic test force at fall arrest, in kN;
F = the peak force generated by a falling person restricted to 6 kN (see NOTE 1);
$\boldsymbol{\gamma_{Q,1}}$ = the partial safety factor = 1,0 (see NOTE 1);
$\boldsymbol{\gamma_M}$ = the partial safety factor = 2,0 (see NOTE 2);

$\boldsymbol{\gamma_{Q,1}}$ is the partial factor for variable actions, also accounting for model uncertainties and dimensional variations (EN 1990).

$\boldsymbol{\gamma_M}$ is the partial factor for a material property, also accounting for model uncertainties and dimensional variations (EN 1990).

NOTE 1: *In the use of a personal fall protection equipment to form a fall arrest system an "energy absorber" is applied. This restricts the peak force to a maximum of 6 kN. The use of the energy absorber also indicates that there is no influence of variable actions, so that the* $\boldsymbol{\gamma_{Q,1}}$ *is fixed at 1,0.*
NOTE 2: *In the Eurocode (EN 1990 Table A.1.2(A) and in the ETAG 006 (clause 5.1.4.1) a value for* $\boldsymbol{\gamma_M}$ *is given of 1,5.*
In NEN 6707 clause 9.3 for $\boldsymbol{\gamma_M}$ *a value of 2 is given. NEN 6707 is dealing with roof coverings.*
Therefore in this EOTA TR for $\boldsymbol{\gamma_M}$ *the value of 2 has been chosen.*

II.4.4.3 Static strength test

Install the test specimen in or on the static test apparatus specified in II.2.3.
Apply for t_s = (30 ± 0,5) minutes in each critical direction of use**,** permitted by the information supplied by the manufacturer**,** a test force for fall arrest ($\mathbf{F_{FA,s}}$) equal to 1**,**5 kN.
Observe, whether the structural anchor holds the force.

The static test force, $\mathbf{F_{FA,s}}$ of 1,5 kN has been derived from the following formula (4).

$$\mathbf{F_{FA,s}} = g \times M \times \gamma_{Q,1} \times 10^{-3} \qquad (4)$$

Whereby,
$F_{FA,s}$ = the static test force for Fall Arrest , in kN
g = the gravitation coefficient ≈ 10 m/sec^2
M = the mass of 100 kg
$\boldsymbol{\gamma_{Q,1}}$ = the partial safety factor = 1,5 (Table I.1.2 of EN 1990)

The duration of the test, $\mathbf{t_s}$, of 30 minutes has been derived from the following formula (5).

$$\mathbf{t_s} = t \times \gamma_M \qquad (5)$$

Whereby,

t_s = the static test duration Fall Arrest, in minutes
t = the representative duration of a hanging person after a fall = 15 minutes
$\boldsymbol{\gamma_M}$ = the partial safety factor = 2,0

$\boldsymbol{\gamma_{Q,1}}$ is the partial factor for variable actions, also accounting for model uncertainties and dimensional variations (EN 1990).

$\boldsymbol{\gamma_M}$ is the partial factor for a material property, also accounting for model uncertainties and dimensional variations (EN 1990).

NOTE: *In the Eurocode (EN 1990 Table A1.2 (A)) and in the ETAG 006 (clause5.1.4.1) a value for* $\boldsymbol{\gamma_M}$ *is given of 1,5.*
In NEN 6707 clause 9.3 for $\boldsymbol{\gamma_M}$ *a value of 2 is given. NEN 6707 is dealing with roof coverings.*
Therefore in this EOTA TR for $\boldsymbol{\gamma_M}$ *the value of 2 has been chosen.*

III RESTRAINT SYSTEM

III.1 PRINCIPLE

For the assessment of the structural anchor in case to be used for a restraint system a dynamic testing shall be performed at low temperature on a small scale test specimen and at high temperature on a full scale test specimen.

For the assessment at **low temperature** a small scale dynamic testing is performed at the chosen low temperature on a small scale test specimen of a top layer of a multi- layered APP modified bitumen roof waterproofing system on which the structural anchor is applied.

For the assessment at **high temperature** a full scale dynamic and static testing is performed at the chosen high temperature on a large test specimen of a complete roof build-up using the combination of the structural anchor applied to the multi-layered SBS modified roof waterproofing system.
The roof build-up shall be a loose laid or mechanically fastened multi-layered roof waterproofing system, both including a joint (overlap) and an insulation material with low compression strength.

III.2 TEST SPECIMEN

III.2.1 Test specimen for the testing at low temperature

The test specimen for the testing at low temperature shall be a “small scale” test specimen in accordance with clause II.2.2.
The number of test specimen shall be three.

III.2.2 Test specimen for the testing at high temperature

The test specimen for the testing at high temperature shall be a “full scale” test specimen in accordance with II.4.2.
The number of test specimen shall be one.

III.3 APPARATUS

The test apparatus for the static test shall be conforming to EN 364 clauses 4.1 and 4.2.
The test apparatus for the dynamic test shall be conforming to EN 795 clauses 5.2.2.1 and 5.2.2.2.
The test lanyard shall be conforming to EN 795 clause 5.2.1.
When necessary, use a connecting line between the test lanyard and the load cell attached to the anchor point made of a steel wire cable 8 mm diameter of a 7 x 19 construction and fitted with swaged eyelet terminations.

Determine the free fall distance of the rigid test mass (see EN 795 clause 5.2.1.4) required to generate a fall arrest load of (4,5 + 0,5/0) kN in the dynamic strength test.

NOTE: *This dynamic load differs from the dynamic load conforming to EN 795 (see III.4.1.4).*

A thermometer, capable of measuring the black standard temperature (BST), shall be conforming to ISO/DIS 4892-1.

For the testing at low temperature a cooling box capable of containing a test specimen with a size according II.2.2 and capable to maintain the temperature up to (- 10 ± 2) °C, (- 20 ± 2) °C or (- 30 ± 2) °C, depending on the chosen low temperature category (TL).

III.4 TEST PROCEDURE

III.4.1 Testing at low temperature by a dynamic strength testing

III.4.1.1 General criteria for testing at low temperature

The general test criteria for testing at low temperature are.

- The testing shall be performed at a temperature of (TL_R ± 2) °C.
  The temperature at restraint (TL_R) shall be chosen from the following low temperature categories being -10 °C (moderate low temperature) or -20 °C (severe low temperature) or -30 °C (extreme low temperature) and shall be indicated in the ETA.
- The test specimen shall be installed in or on the test apparatus, as appropriate, where relevant using a clamping fixing.

- Where the information provided by the manufacturer permits loading in more than one direction (e.g. in tension and in shear) the test specimen shall be tested in each critical direction.

NOTE: *The categorisation of the low temperature at restraint (TL_R) is derived from Table 6(a) of ETAG 005 Part 1.*
The category TL -30 °C (extreme low temperature) shall only be taken into account when declared by the Member States (see CPD – art.3.2)

III.4.1.2 Dynamic strength

The dynamic strength shall be determined in accordance with the test procedure as detailed in EN 795 clause 5.3.3.

- Attach a load cell to the anchor point.
- Attach one end of the test lanyard to the rigid test mass by means of a connector.
- Attach the other end of the test lanyard directly to the load cell by means of a connector, or when necessary, attach a connecting line between the other end of the test lanyard and the load cell by means of a connector at both ends.
- Attach a quick release device to the rigid test mass.
- Move the rigid test mass downwards until the test lanyard holds the mass.
- Raise then the rigid test mass to the free fall distance as determined in III.3 and hold it at a maximum of 300 mm horizontally from the anchor point or pulley. Release the rigid mass and observe and record whether the rigid mass is arrested and is held clear of the ground.

III.4.1.4 Dynamic Force

The dynamic test force $\mathbf{F_{R,d}}$ of 4,5 kN has been derived from the following formula (6).

$$\mathbf{F_{R,d}} = F \times \gamma_{Q,1} \times \gamma_M \qquad (6)$$

Whereby,
$F_{R,d}$ = the dynamic test force at restraint, in kN;
F = the peak force generated by a running or stumbling person of 1,5 kN, based on experiments of practice simulations;
$\gamma_{Q,1}$ = the partial safety factor = 1,5 (table I.1.2 of EN 1990);
γ_M = the partial safety factor = 2,0 (see NOTE 1).

$\gamma_{Q,1}$ is the partial factor for variable actions, also accounting for model uncertainties and dimensional variations (EN 1990).

γ_M is the partial factor for a material property, also accounting for model uncertainties and dimensional variations (EN 1990).

NOTE: *In the Eurocode (EN 1990 Table A1.2(A)) and in the ETAG 006 (clause5.1.4.1) a value for γ_M is given of 1,5.*

In NEN 6707 clause 9.3 for γ_M *a value of 2 is given. NEN 6707 is dealing with roof coverings.*
Therefore in this EOTA TR for γ_M *the value of 2 has been chosen.*

III.4.2 Testing at high temperature by a dynamic and static strength test

III.4.2.1 General criteria for testing at high temperature

The general test criteria for testing at high temperature are the following.

- The testing shall be performed at a temperature of (TH_R ± 5) °C.
  The temperature TH_R (High Temperature at Restraint) shall be indicated in the ETA.
- The test specimen shall be installed in or on the test apparatus, as appropriate, where relevant using a clamping fixing.
- Where the information provided by the manufacturer permits loading in more than one direction (e.g. in tension and in shear) the test specimen shall be tested in each critical direction.

III.4.2.2 Test procedure for testing at high temperature by a dynamic strength test

The dynamic strength shall be determined in accordance with the test procedure as detailed in EN 795 clause 5.3.3.

- Attach a load cell to the anchor point.
- Attach one end of the test lanyard to the rigid test mass by means of a connector.
- Attach the other end of the test lanyard directly to the load cell by means of a connector, or when necessary, attach a connecting line between the other end of the test lanyard and the load cell by means of a connector at both ends.
- Attach a quick release device to the rigid test mass.
- Move the rigid test mass downwards until the test lanyard holds the mass.
- Raise then the rigid test mass to the free fall distance as determined in III.3 and hold it at a maximum of 300 mm horizontally from the anchor point or pulley. Release the rigid mass and observe and record whether the rigid mass is arrested and is held clear of the ground.

III.4.2.3 Static strength test

Install the test specimen in the static strength apparatus to apply the test force in the direction or directions in use in service and submit to the structural anchor a static test force at restraint ($\mathbf{F_{R,s}}$) equal to 300 N for (5 ± 0,5) minutes.
Observe, whether each structural anchor holds the force and the permanent deformation shall be less than 10,0 mm.

NOTE 1: *The static test force for restraint (*$F_{R,s}$*) of 300 N has been derived from clause 6.3.1.1 of EN 13374.*

NOTE 2: *The time of 5 minutes has been chosen as being representative for the time of loading at use, incorporating enforceable circumstances.*
NOTE 3: *The maximum permanent deformation has been derived from clause 5.3.2 of EN 795.*

ANNEX A – Justification of the choices made on the roof construction, insulation material in the full scale testing, the types of roofing membrane and the loading condition for “bitumen” products

A.1 THE ROOFING CONSTRUCTION

There are four methods of attaching or fixing a multilayered modified bitumen roof waterproofing system to the deck/substructure:

- partially bonded (P);
- fully bonded (F);
- mechanically fastened (MF);
- loose laid and ballasted (L).

The principle of the structural anchor bonded to the roof waterproofing system is not based on directing the load on the structural anchor directly to the roof construction underneath the roof waterproofing system. The load on the structural anchor is transferred to the roof waterproofing system and then, spread over a larger area, further to the insulation material and deck. In this way the forces within the roof materials are reduced significantly. The forces within the roof waterproofing system depend on the method of attaching of the roof waterproofing system.

A somewhat flexible fixing method, like loose laid and ballasted as well as partially bonded systems, allow some movement of the roof waterproofing system, resulting in a maximum spread of load within the roof waterproofing system over a larger area. The forces on the joints of the roof waterproofing system are reduced, but the deformation of the roof waterproofing system (including folds) is at its most. For loose laid and ballasted systems the system allows for more movement and thus the deformation larger than for partially bonded systems.

A more rigid fixing method, like fully bonded and mechanically fastened systems, allow very little movement of the roof waterproofing system, resulting in less spread of load within the roof waterproofing system. The forces on the joints in the roof waterproofing system are at its highest. For mechanically fastened systems the fixing is more rigid and thus the forces on the joints are higher than for fully bonded systems.

So loose laid and ballasted roof waterproofing systems and mechanically fastened roof waterproofing systems are considered the most critical fixing methods for assessing the effect on the strength of the roof waterproofing system, caused by the load on the structural anchor. Furthermore, the ballast layer is not considered because it makes the performance of the test unnecessarily complex. Leaving the ballast layer out only makes the test even more severe.

A.2 INSULATION MATERIAL IN THE FULL SCALE TESTING

The compression strength of the insulation material in a roof construction affects the deformation of the roof waterproofing system and the structural anchor, as well as the absorption of the (dynamic) forces on the structural anchor. A rigid insulation material with a high compression strength results in very little deformation and thus higher peak forces, especially when the structural anchor is dynamically loaded. An insulation material with a low compression strength results in more deformation of the roof waterproofing system and structural anchor, especially when the structural anchor is statically loaded.
Because the strength of this type of structural anchor, installed on a roof waterproofing system, is much more sensitive to deformation of the structural anchor and the roof waterproofing system, an insulation material with low compression strength is considered as the most critical.

A.3 TYPES OF ROOFING MEMBRANES AND LOADING CONDITIONS FOR BITUMEN PRODUCTS

In principle modified bitumen membranes are fairly compatible. There are slight differences in the relevant product properties within the range of multilayered modified bitumen roof waterproofing systems. The most relevant difference in properties, if any, is between polymeric and elastomeric modified bitumen membranes. In general, polymeric modified bitumen membranes are more rigid but the adhesion strength and joint strength is somewhat lower. Elastomeric modified bitumen membranes are a bit softer and flexible and the adhesion strength and joint strength is somewhat higher. APP modified bitumen membranes (Atactic Polypropylene) are the most common polymeric modified bitumen membranes and SBS modified bitumen membranes (Styrene Butadiene Styrene) are the most common elastomeric modified bitumen membranes. These two types of roofing membranes, APP and SBS, are therefore considered to be representative for the complete range of modified bitumen roof waterproofing systems.

At high temperature the (long duration) static load testing is considered the most critical test for the application with SBS modified bitumen products compared to dynamic load testing. This is because of the viscous nature of bitumen.
At low temperature the dynamic load testing is considered the most critical test for the application with APP modified bitumen products compared to static load testing.

A.4 FALL ARREST AND RESTRAINT SYSTEMS

In accordance with EN 363 a distinction has been made between fall arrest systems and restraint systems. The characteristic “loading at use” is not addressed in EN 795.
In this Technical Report for a representative loading in dynamic and static conditions as a starting point for fall arrest systems as well as for restraint systems the characteristic “loading at use” has been defined.

A.5 DYNAMIC TEST APPARATUS

For assessing the strength of the assembly of the steel components of the structural anchor the apparatus is conforming to EN 795.
However, there is no sufficient safety added to the intended load in use within EN 795.
Therefore, for assessing the strength of the connection of the structural anchor to the roof, the necessary safety factors conforming to the Eurocodes (see II.4.4.2.3) are taken into account. The test procedure as detailed in this Technical Report is generating a higher dynamic load.

ANNEX B – NORMATIVE REFERENCES

ETAG 005 – Part 1 : March 2004	Guideline for European Technical Approval of LIQUID APPLIED ROOF WATERPROOFING KITS – PART 1: GENERAL
ETAG 006 : March 2000	Guideline for European Technical Approval of SYSTEMS OF MECHANICALLY FASTENED FLEXIBLE ROOF WATERPROOFING MEMBRANES
EOTA TR 010 : May 2004	Exposure procedure for artificial weathering
EN 363 : 2008	Personal fall protection equipment – Personal fall protection systems
EN 364 : 1992	Personal protective equipment against fall from a height
EN 795 : July 2012	Personal fall protection equipment – Anchor devices
EN 1296 : 2000	Flexible sheets for waterproofing – Bitumen, plastic and rubber sheets for roof waterproofing – method of artificial ageing by long term exposure to elevated temperatures
EN 1990 : 2002 + A1 + A1/C1 : 2011	Eurocode – Basis of structural design
EN 12317-1 : 1999	Flexible sheets for waterproofing – Part 1: Bitumen sheets for roof waterproofing – Determination of shear resistance of joints
EN 13162 : 2009	Thermal insulation products for buildings – Factory made mineral wool (MW) products – Specification
EN 13707 : 2004 + A2:2009	Flexible sheets for waterproofing – Reinforced bitumen sheets for roof waterproofing – Definitions and characteristics
EN 13374: 2004	Temporary edge protection systems – Product specification, test methods
ISO/DIS 4892-1 : December 2008	Methods of exposure to laboratory light sources – Part 1: General guidance
NEN 6707 : 2001	Bevestiging van dakbedekkingen – Eisen en bepalingsmethoden (Fixings of roof coverings – Requirements and determination methods)