EUROPEAN ASSESSMENT DOCUMENT

EAD 340059-00-0106

July 2018

FALLING ROCK PROTECTION KITS

www.eota.eu

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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) No 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 is applicable to falling rock protection kits with a MEL (Maximum Energy Level) as defined in 2.2.1.1.2 greater than or equal to 100 kJ. The kit is made up of two lateral functional modules and at least one central functional module; this means minimum three fields of interception structure and 4 posts. The foundation is not considered part of the kit. Products covered by this EAD are not covered by a harmonised European standard (hEN) and by the EAD 340089-00-0106, due to different MEL considered in the latter one.

A reference height of the falling rock protection kit may be stated in the ETA according to the technical documentation of the manufacturer, whereas it is bounded by a lower limit that cannot be lower than the nominal height (see section 1.3.14) rounded to the nearest half meter and an upper limit that cannot be raised by:

(a) more than 1 metre for a nominal height rounded to the nearest half meter superior or equal to 4 metres,

or

(b) more than 0,5 metre for a nominal height rounded to the nearest half meter less than 4 metres.

A falling rock protection kit is made up of:

a) An **interception structure**, which is made of principal net and optional additional layer. The principal net may be made up of metallic ropes, wires and/or bars of different types, for example rope nets joined with clamps, submarine nets or ring nets.

Optional additional layer: usually with a finer meshwork than the principal net. If the kit has been tested without an additional layer, it may be added on site, if it doesn't significantly affect the performance of the kit. On the contrary, if the kit has been tested with additional layer, this additional layer is considered to be a part of the assessed kit.

The interception structure can deform elastically and/or plastically while transferring the direct impact of mass to the connection components or directly to the support structure.

b) A **support structure** made up of metallic posts (for example, tubular or other sections) and base plates (if any) in different geometry and dimensions; the posts are connected to the base plates in a manner corresponding to their structural behaviour (for example pinned, clamped). The posts at their bottoms can be also supported by suitably arranged ropes.

Posts ensure the position of interception structure and they can be connected to the interception structure directly or through connection components.

The spacing of the posts should be chosen by the Manufacturer.

c) **Connection components**: they may consist of metallic ropes, wires and/or bars of different types, junctions, wire rope grips, energy dissipating devices (elements which are able to dissipate energy and/or allow a controlled displacement when activated).

Connection components transmit the forces to the foundations. In order to allow the deformation, devices can be installed onto the structure, which permits a controlled lengthening.

The following schemes (Figures 1 and 2) give an example of a kit and explain in general terms the different components of the kit.

The components comprising the falling rock protection kit are detailed in Clause 3 of the EAD by means of their relevant parameters.

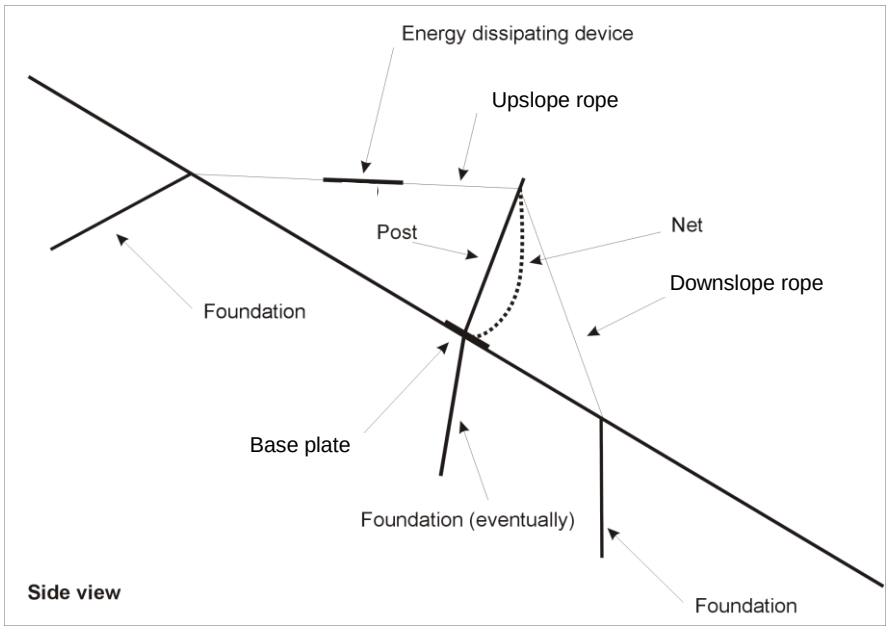

Figure 1 – Lateral view of a falling rock protection kit

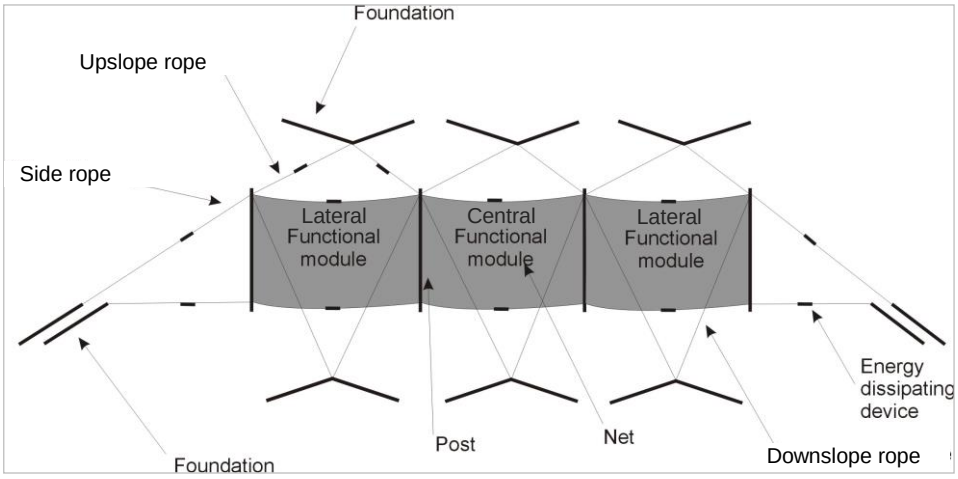

Figure 2 – Front view of a falling rock protection kit

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 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.

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

1.2.1 Intended use(s)

This EAD concerns the falling rock protection kits used to stop moving rock blocks on a slope with a defined energy level.

This EAD covers a range of ambient temperature of [-20 °C ; +50 °C].

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 the falling rock protection kits for the intended use of 25 years, when installed in the works, provided that the falling rock protection kit is subject to appropriate installation, use and maintenance (see 1.1).

This working life is intended to be assumed without any rock impact and under consideration of the atmospheric conditions according to EN ISO 9223 in terms of corrosivity category C2. For corrosivity categories C3 and C4 according to EN ISO 9223 a working life of 10 years for products according to this EAD applies. 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 works1.

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 Falling rock protection kit

Construction product consisting of nets (interception structure according to clause 1.1), posts (support structure according to clause 1.1), ropes (connection components according to clause 1.1) and energy dissipating devices (connection components according to clause 1.1).

1.3.2 Principal net

Bearing element acting as a surface.

1.3.3 Posts

Part of the support structure supporting the bearing ropes and nets.

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1 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 Base plate

Structural element placed between post and ground and/or foundation.

1.3.5 Ropes (bearing)

Bearing elements serving to transmit the forces into the posts, base plates and upslope ropes.

1.3.6 Upslope ropes

Upslope ropes serving to transmit the post head forces to the foundations.

1.3.7 Downslope ropes

Downslope ropes serving to hold the posts in erected position.

1.3.8 Side ropes

Ropes serving to hold the outer posts in correct position.

1.3.9 Energy dissipating devices

Devices fitted on ropes in order to absorb energy.

1.3.10 Additional layer (secondary mesh)

Mesh placed on the principal net on the upslope side.

1.3.11 Foundations

Bearing elements transmitting the rope forces and post forces into the ground.

1.3.12 Energy level

The kinetic energy of a regular block impacting the considered kit. It is expressed as SEL (Service Energy Level) and MEL (Maximum Energy Level). The objective of SEL test is to assess how the kit withstands successive impacts. The objective of MEL is to specify a maximum capacity of the falling rock protection kit.

1.3.13 Reference slope

The slope downhill from the kit extended in the same direction to maximum elongation of kit.

1.3.14 Nominal height

The nominal height h_N is measured orthogonally to the reference slope and is the minimum distance between the upper bearing/support rope and the base line (see 1.3.17) before the impact (Figure 3 and 4).

If bearing ropes are not foreseen according to the design of the kit, the upper edge of the principal net is the reference for the measurement instead.

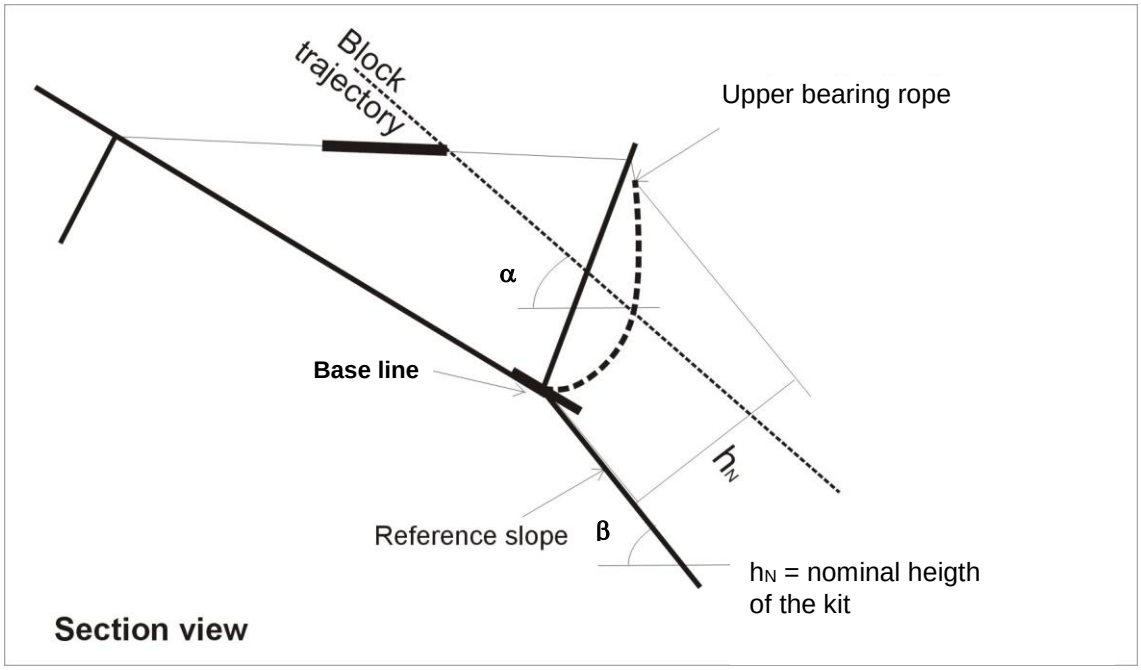

Figure 3 – Nominal height of the kit

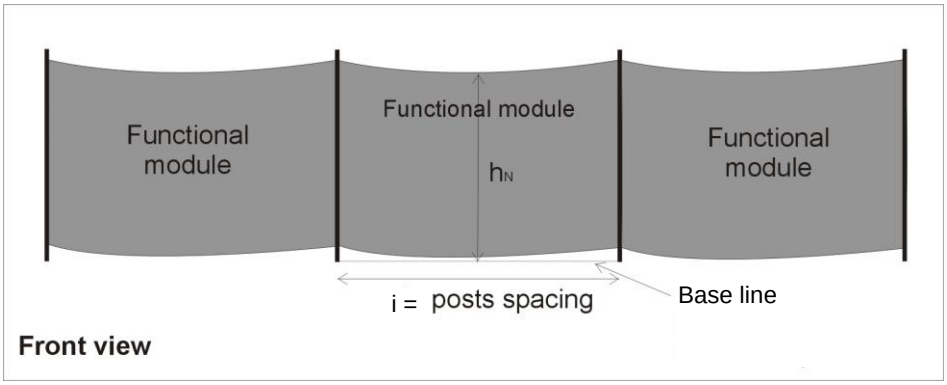

Figure 4 – Front view of the kit

1.3.15 Maximum elongation of the kit

The downhill displacement of the net measured parallel to the reference slope during impact starting from the most advanced downslope point of the net before test. The measure has to be taken during dynamic phase of impact. See Figure 5.

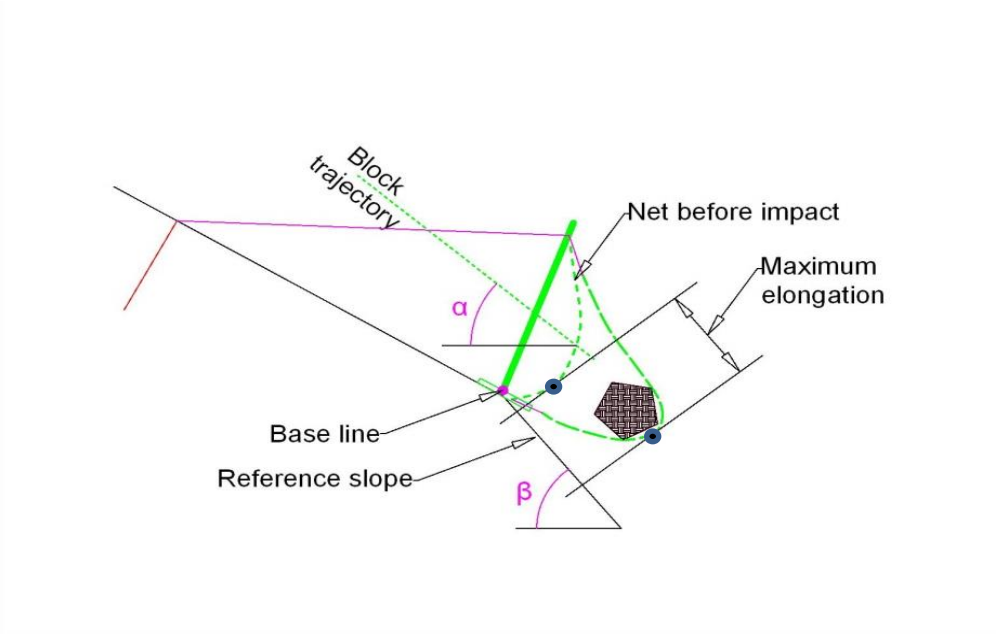

Figure 5 – Maximum elongation

1.3.16 Residual height

The residual height h_R is the minimum distance between the lower and the upper bearing ropes, measured orthogonally to the reference slope after the impact without removing the block (Figure 6).

If bearing ropes are not foreseen according to the design, the edges of the principal net are the references for the measurement.

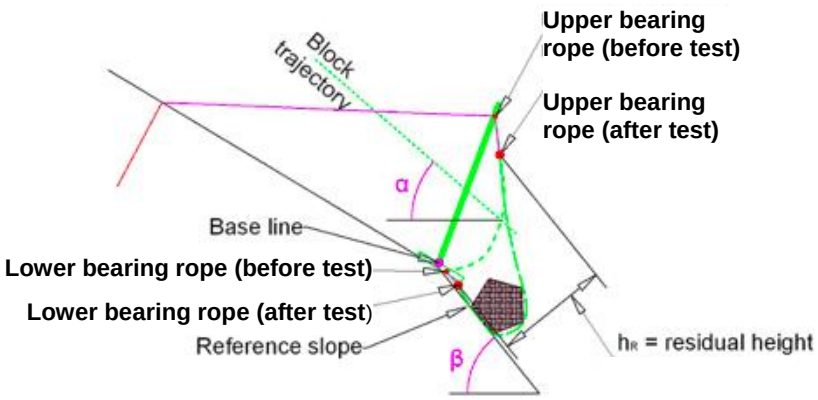

Figure 6 – Residual height

1.3.17 Base line

The base line is defined as the line passing through the intersections of the axes of the posts and the upper surface of the base plates or - in absence of base plate - the ground surface.

1.3.18 Block trajectory

Trajectory followed by the impacting block.

1.3.19 Impact speed

Impacting block mean speed, calculated (according to A.3) on the last metre before block contact with the interception structure.

1.3.20 Lateral gaps of the assembled kit

The lateral gap can be defined either by:

- maximum lateral displacement of the net (at outer post) from its initial position, measured parallel to the base line (approach 1),

or

- maximum distance of the net after the test from the initial position of the outer post, measured parallel to the base line (approach 2).

1.3.21 Central Functional module

Module consisting of 2 inner posts, an interception structure and relevant connection components.

1.3.22 Lateral Functional modules

Module consisting of interception structure and relevant connection components, connected to outer and inner post of the falling rock protection kit.

1.3.23 Braking time

The time between the moment of the first contact between the block and the interception structure and the moment of the maximum elongation of the kit during the test.

1.3.24 Notations

α : Angle between block trajectory and horizontal.

β : Angle between reference slope and horizontal

h_N : Nominal height

h_R : Residual height

i : Post spacing

V_{impact} : Impact speed

E_c : Kinetic impact energy

m : Mass of the impacting block.

2 ESSENTIAL CHARACTERISTICS AND RELEVANT ASSESSMENT METHODS AND CRITERIA

2.1 Essential characteristics of the product

Table 1 shows how the performance of the falling rock protection kit is assessed in relation to the essential characteristics.

Table 1: Essential characteristics of the product 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 *(level, class, description)*
Basic Works Requirement 1: Mechanical resistance and stability			
1	Energy absorption	See 2.2.1.1	Description
	- Service Energy Level (SEL1 and SEL 2)	See 2.2.1.1.1	Level
	- Maximum Energy Level (MEL)	See 2.2.1.1.2	Level and description
2	Residual height		
	- at Service Energy Level (SEL1)	See 2.2.1.2	Level
	- at Maximum Energy Level (MEL)	See 2.2.1.2	Level and description
3	Maximum Elongation		
	- at Service Energy Level (SEL1 and SEL 2)	See 2.2.1.3	Level
	- at Maximum Energy Level (MEL)	See 2.2.1.3	Level
4	Lateral gap		
	- at Service Energy Level (SEL1)	See 2.2.1.4	Level and description
	- at Maximum Energy Level (MEL)	See 2.2.1.4	Level and description
5	Actions on foundations		
	- at Service Energy Level (SEL1 and SEL 2)	See 2.2.1.5	Level and description
	- at Maximum Energy Level (MEL)	See 2.2.1.5	Level and description
6	Durability	See 2.2.1.6	Description
Basic Works Requirement 3: Hygiene, health and the environment			
7	Content, emission and/or release of dangerous substances	See 2.2.2	--
	• leachable substances	See 2.2.2.1	Description

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

Characterisation of products to be assessed shall be done in accordance with available specifications, notably each type of energy dissipating devices according to Clause 3.4.1, taken from the same delivery (lot) as for the installed devices in the kit.

2.2.1 Mechanical resistance and stability

2.2.1.1 Energy absorption

Based on the results of both tests given in clauses 2.2.1.1.1 (SEL 1, SEL 2) and in clause 2.2.1.1.2 (MEL), description by means of stating the resulting category according to Table 2 shall be given in the ETA.

For the categorisation, the measured energy values must not be less than values given in Table 2.

Table 2 – Falling rock protection kit categories

Energy absorption categories	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
SEL (kJ)	-	85	170	330	500	660	1000	1500	> 1500
MEL (kJ) with MEL ≥ 3 x SEL	100	250	500	1000	1500	2000	3000	4500	> 4500

2.2.1.1.1 Service Energy Level (SEL 1 and SEL 2)

The Service Energy Level (SEL) shall be assessed according to Annex A in this EAD, according to which two subsequent launches (the SEL 1 and the SEL 2) of a block shall be carried out into the falling rock protection kit. No maintenance is allowed between the first and the second launch at SEL.

The resulting energy levels for SEL 1 and SEL 2 (according to A.3) shall be given in the ETA.

The SEL 1 launch is passed if:

- The block is stopped by the kit.
- No ruptures occur in the connection components (which remain connected to foundations), posts or ropes. The rupture of a connection component is defined as the complete separation of the component itself into two distinct parts.
- The opening of the mesh of the principal net and the gaps between the principal net and the bearing rope(s) are not be larger than two times the initial size of mesh of the principal net. Elements like mechanical fuses, which are designed to break under impact conditions, are excluded from the assessment; they shall be specifically listed in the installation document.
- The residual height of the kit after the test (without removing the block) is greater than or equal to 70% of the nominal height.
- The residual net height at the posts (even in case a number of fuses are broken in that area) is everywhere larger than (or at least equal to) the residual height according to 1.3.16 (see Figure 7).
- The block has not touched the ground until the kit has reached the maximum elongation during the test.

The SEL 2 launch is passed if:

- The block is stopped by the kit.
- The block has not touched the ground until the kit has reached the maximum elongation during the test.

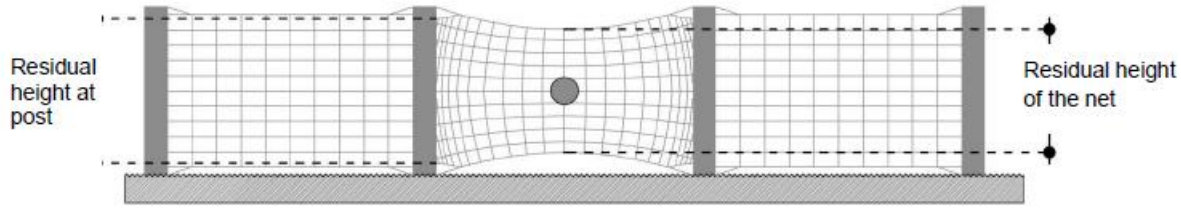

Figure 7 – Residual net height at the posts after the SEL 1

2.2.1.1.2 Maximum Energy Level (MEL)

The Maximum Energy Level (MEL) (according to A.3) shall be assessed according to Annex A of this EAD. The resulting energy level for MEL shall be given in the ETA.

The MEL launch is passed if:

- The block is stopped by the kit.
- The block has not touched the ground until the kit has reached the maximum elongation during the test.

A detailed description of damages of the kit has to be provided and included in the ETA.

2.2.1.2 Residual height

The nominal height of the kit before the SEL 1 and MEL launches shall be assessed according to Annex A in this EAD.

The value of residual height after MEL and SEL 1 shall be assessed according to Annex A of this EAD.

The following values shall be given in the ETA for both SEL 1 and MEL:

- nominal height: h_N
- residual height: h_R
- ratio between residual and nominal heights: h_R / h_N

The falling rock protection kit considering the residual height for MEL shall be ~~classified~~ categorised as follows:

- Category A: $h_R \geq 0{,}5\ h_N$
- Category B: $0{,}3\ h_N < h_R < 0{,}5\ h_N$
- Category C: $h_R \leq 0{,}3\ h_N$ or complete break of upper and/or lower bearing rope; in the absence of such rope, complete break of longitudinal connection component (the longitudinal connection component can be made by one or more ropes, wires or similar longitudinal components which keep the principal net in place and run along the whole span).

The category of the kit regarding residual height shall be given in the ETA.

2.2.1.3 Maximum Elongation

The maximum elongation (see Figure 5) of the kit during the MEL and both SEL launches shall be assessed according to Annex A in this EAD and all three maximum elongations shall be given in the ETA.

The assessment of the maximum elongation after SEL 2 test includes plastic deformation after SEL 1.

2.2.1.4 Lateral gaps

After the SEL 1 and MEL launches, the lateral gaps of the kit (as defined following one of the two approaches given in 1.3.20) shall be assessed according to Annex A of this EAD. The chosen approach, values and description shall be given in the ETA.

2.2.1.5 Actions on the foundations

The forces acting on the foundations shall be assessed according to Annex A of this EAD and shall be given in the ETA as:

- measured peak force values
- time-force diagrams and load cells installation scheme.

2.2.1.6 Durability of the kit

The durability is assessed under consideration of the corrosivity categories according to EN ISO 9223 given in Clause 1.2.2, for each component, according to standards relevant for given type of corrosion protection, as follows:

- post and base plates (made of carbon steel) hot dip galvanized according to EN ISO 1461;
- For components made of stainless steel it shall be assessed according to EN 1993-1-4, Annex A if the component is suitable for the atmospheric conditions according to EN ISO 9223 for which the kit is intended to be used in and with respect to the intended working life.
- For ropes/wires it shall be assessed according to EN 10264-2/EN 10244-2 if the coating is suitable for the atmospheric conditions according to EN ISO 9223 for which the kit is intended to be used in and with respect to the intended working life.
- wire rope grips, shackles and other ancillaries hot dip galvanized according to EN ISO 1461 or zinc plated according to EN ISO 4042 or non-electrolytically zinc flake coated (grade A) according to EN ISO 10683 and EN 13858.

Type and thickness/mass of coating shall be expressed in the ETA.

Additional coating, not subject of the tested kit, may be applied if not influencing the assessed performance of the kit negatively.

2.2.2 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[2],

[2] The manufacturer may be asked to provide to the TAB the REACH related information which he must accompany the DoP with (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
- to provide a written declaration to the TAB stating whether the product (or constituents of the product) contain(s) substances which are classified as dangerous according to Directive 67/548/EEC and Regulation (EC) No 1272/2008 and listed in the "Indicative list on dangerous substances" of the SGDS.

- Any information provided by the manufacturer regarding the chemical composition of the products may not be distributed to EOTA or to TABs.

after identifying the release scenarios (in accordance with EOTA TR 034:2015) 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. Purely inorganic materials (e.g. boards, adhesives) do not have to be tested.

The identified intended release scenarios for this product (mesh / wire with additional organic coating only) 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 has to be checked.

2.2.2.1 Leachable substances

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 according to CEN/TS 16637-2:2014 for scenario I according to Annex A, Cl. A.1. The leachant shall be pH-neutral demineralised water and the ratio of liquid volume to surface area shall be (80 ± 10) l/m².

The each test specimen to be tested shall be prepared by cutting off the piece of finally organic coated wire of length *l* [mm] calculated according to 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 according to 2.2.4.2 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 according to EN ISO 6341
- Toxicity test with algae according to ISO 15799
- Luminescent bacteria test according to 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 according to OECD Test Guideline 301 part A, B or E.

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.

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: Decision 2003/728/EC.

The system is: 1

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.

Table 3: Control plan for the Manufacturer: cornerstones

N°	Subject/type of control *(product, raw/constituent material, component - indicating characteristic concerned)*	Test or control method	Criteria, if any	Minimum number of samples[3]	Minimum frequency of control[3]
Factory Production control (FPC) including testing of samples in accordance with a control plan					
1	**Posts and base plates:** - steel grade	EN 1090-2	Laid down in control plan	1 per type	Every delivery (inspection document according to EN 10204, type 3.1 or 2.2)
	- dimensions	EN 1090-2	Laid down in control plan	1 per type	Every delivery
	- corrosion protection	EN 1090-2	Laid down in control plan	3 tests per lot are requested with at least 3 tests per 50 posts/plates	
	- welding	EN 1090-2	Laid down in control plan	For each post, welding shall be verified by visual check	In addition, at least one Non-destructive test - NDT (type of NDT shall be relevant for the selected weld) each year for each supplier shall be performed.
2	**Ropes** (acc. to 1.3.1) and ropes in net: - designation	EN 12385-2	Control plan	3 per type	Each reel or 50 panels Alternatively 1 per year test + inspection document for each delivery according to EN 10204.type 3.1
	- breaking force and elongation	EN 12385-1	Control plan	3 per type	
	- geometrical properties	EN 12385-4	Control plan	3 per type	
	- corrosion protection	EN 10264-2/ EN 10244-2	Control plan	3 per type	

[3] Once constancy of production was established, it is possible to reduce number of test samples and frequencies of controls, subject of agreement between Manufacturer and Notified Body. Once any failure has occurred, the frequency and the number of test samples have to be reintroduced according to table 3.

3	**Energy dissipating devices:** - force-displacements diagram	Clause 3.4.1	Control plan: difference from the declared value of activation force: ± 15% [4]	Case 1[5]: 2 per type	Case 1: 1 per year
				Case 2: 1 per type	Case 2: every 100 pieces
	- dimensions	Clause 3.4.1	Control plan	Case 1: 2 per type	Case 1: 1 per year
				Case 2: 1 per type	Case 2: every 100 pieces
	- Mechanical properties and corrosion protection	Laid down in the control plan			Every delivery (inspection document according to EN 10204, type 3.1)
4	**Principal Net**				
	Rope net, ring net, double twisted steel wire mesh, chain link wire mesh: - dimensions for: - rope net - ring net - double twisted steel wire mesh - chain link wire mesh	- EAD 230005-00-0106 cl. 2.2.1.5 - EAD 230004-00-0106 cl. 2.2.1 - EAD 230008-00-0106 cl. 2.2.1 - EAD 230025-00-0106 cl. 2.2.1	Control plan	3 per type	Each delivery or every 50 panels of the same delivery
	- breaking force of 3 ring chain[6] (ring net)	EAD 230004-00-0106 cl. 2.2.1	Control plan	3 per type	Every 50 panels of the same delivery; in case of less than 50 panels/year: once per year per supplier
	- wire breaking/elongation	EN 10218-1 cl. 3	Control plan	EN 10204/3.1	
	- slipping force in the clamps (rope nets)	EAD 230005-00-0106 cl. 2.2.1.4	Control plan	3 per type	
	- tensile strength of double twisted steel wire mesh[6]	EAD 230008-00-0106 cl. 2.2.8	Control plan	3 per type	
	- tensile strength of chain link wire mesh	EAD 230025-00-0106 cl. 2.2.3	Control plan	3 per type	
	- corrosion protection for rope net	EN 10264-2/EN 10244-2	Control plan	EN 10204/3.1	each delivery
	- corrosion protection for ring net and wire mesh	EN 10244-2	Control plan	EN 10204/3.1	each delivery
	<u>Other type of Principal Net</u>				
	- dimensions	Control plan	Control plan	3 per type	each delivery or every 50 panels of the same delivery
	- mechanical properties, e.g.: - rope type - designation - breaking force of net - galvanization or other	Control plan	Control plan	3 per type	each delivery or every 50 panels of the same delivery in case of less than 50 panels/year: once

[4] If the force elongation diagram does not allow to define the exact point of activation force, then this condition may not apply

[5] Case 1 applies when less than 200 pieces are produced during the year; otherwise Case 2 applies.

[6] For different type of net the test can be modified in appropriate way depending on the design of the principal net.

	corrosion protection				per year per supplier
5	**Wire rope grips** covered by EN 13411-5: - type and size	EN 13411-5	Control plan	EN 10204/2.2	each delivery
	Wire rope grips not covered by EN 13411-5: - type and size	standards as applicable	Control plan	3 per type	every 5.000 pieces of the same type
6	**Shackles** - breaking load of shackles covered by EN 13889	EN 13889	Control plan	EN 10204/2.2	each delivery
	- breaking load of shackles not covered by EN 13889	standards as applicable	Control plan	3 per type	every 5.000 pieces of the same type

Factory Production Control (FPC) system

The kit manufacturer should exercise permanent internal control of the production. All the elements, requirements and provisions adopted by the manufacturer should be documented in a systematic manner in the form of written policies and procedures. The factory production control (FPC) system shall ensure the constancy of performance.

A control plan shall be agreed between kit manufacturer and Technical Assessment Body (TAB) issuing the ETA.

For sampling for component testing, it is suggested to record the following minimum information:

- date and time of manufacture,

- type of product,

- material specification,

- all results of the verifications performed within the control plan.

If not stated otherwise in the standards referred to in Table 3, regarding calibration, accuracy, etc., the conditions stated in Annex A and Clause 3.4.1 apply.

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 Falling Rock Protection Kit are laid down in Table 4.

Table 4: 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	Ascertain that the factory production control with the staff and equipment are suitable to ensure a continuous and orderly manufacturing of the protection kits	According to Table 3.			1
Continuing surveillance, assessment and evaluation of factory production control					
2	Verify that the system of factory production control and the specified automated manufacturing process are maintained taking account of the control plan	According to Table 3.			1/year

3.4 Special methods of control and testing used for the verification of constancy of performance

3.4.1 Test Method for Energy Dissipating Devices

The aim of this test is to determine the force - displacement diagram of energy dissipating devices.

The test apparatus is a calibrated testing machine properly adjusted for tension test of tested energy dissipating device. The testing machine shall be of class 1 (EN ISO 7500-1).

The energy dissipating device to be tested is mounted in the testing machine and a slight tension is given to stabilize the system, then the force is reduced again to zero before the test starts. Next, the energy dissipating device is tensioned by the testing machine with a recommended displacement speed of 2 mm/s. The total elongation of the device shall correspond to its maximum elongation (if lower than 1 m) or to an elongation of 1 m.

The test report shall contain:

- Name of laboratory and name of operator who performed the tests
- Date of test
- Detailed and particular description of test specimen: type of device, materials of components, corrosion protection, etc.
- Nominal dimensions of test specimen
- Description of testing apparatus
- Description of failure mode
- Recorded force- displacement diagram

- Activation force if relevant
- Maximum Elongation if relevant.

4 REFERENCE DOCUMENTS

As far as no edition date is given in the list of standards thereafter, the standard in its current version at the time of issuing the European Technical Assessment is of relevance.

CPR Regulation (EU) No 305/2011 of the European Parliament and of the of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC

EN 1090-1:	Execution of steel structures and aluminium structures. Part 1: Requirements for conformity assessment of structural components.
EN 1090-2:	Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures
EN 10204:	Metallic products – Types of inspection documents.
EN 10244-2:	Steel wire and wire products – Non-ferrous metallic coatings on steel wire – Part 2: Zinc or zinc alloy coatings.
EN 10264-2:	Steel wire and wire products – Steel wire for ropes – Part 2: Cold drawn non alloy steel wire for ropes for general applications.
EN 12385-1:	Steel wire ropes – Safety – Part 1: General requirements.
EN 12385-2:	Steel wire ropes – Safety – Part 2: Definitions, designation and classification.
EN 12385-4:	Steel wire ropes – Safety – Part 4: Stranded ropes for general lifting applications.
EN 13411-5:	Terminations for steel wire ropes – Safety – Part 5: U-bolt wire rope grips.
EN 13858:	Corrosion protection of metals — Non-electrolytically applied zinc flake coatings on iron or steel components.
EN 13889:	Forged steel shackles for general lifting purposes - Dee shackles and bow shackles Grade 6 – Safety.
EN ISO 1461:	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods (ISO 1461:2009).
EN ISO 4042:	Fasteners – Electroplated coatings (ISO 4042:1999).
EN ISO 10683:	Fasteners — Non-electrolytically applied zinc flake coatings.
EN ISO 7500-1	Metallic materials – Verification of static uniaxial testing machines – Part 1: Tension/compression testing machines – Verification and calibration of the force-measuring system.
EN 1993-1-4:	Eurocode 3: Design of steel structures - Part 1-4: General rules - Supplementary rules for stainless steels.
EAD 230004-00-0106	“Wire ring mesh panels”, OJEU 2016/C 172/03.
EAD 230005-00-0106	“Wire rope net panels”, OJEU 2016/C 172/03.
EAD 230008-00-0106	“Double twisted steel wire mesh reinforced or not with ropes”, OJEU 2016/C 172/03.
EAD 230025-00-0106	“Flexible facings systems for slope stabilization and rock protection”, OJEU 2016/C 378/08.

ANNEX A - IMPACT TEST METHOD

This annex describes the impact test method procedure of the falling rock protection kit.

A.1 Test site

The test site is a structure, which shall be able to accelerate a block to the impact speed and to allow the block to impact the kit with the necessary accuracy. The slope downhill from the kit is at least parallel to the block trajectory in the last metre before the impact. Tolerance is defined in Figure A.1 (β angle). This slope is defined as the reference slope.

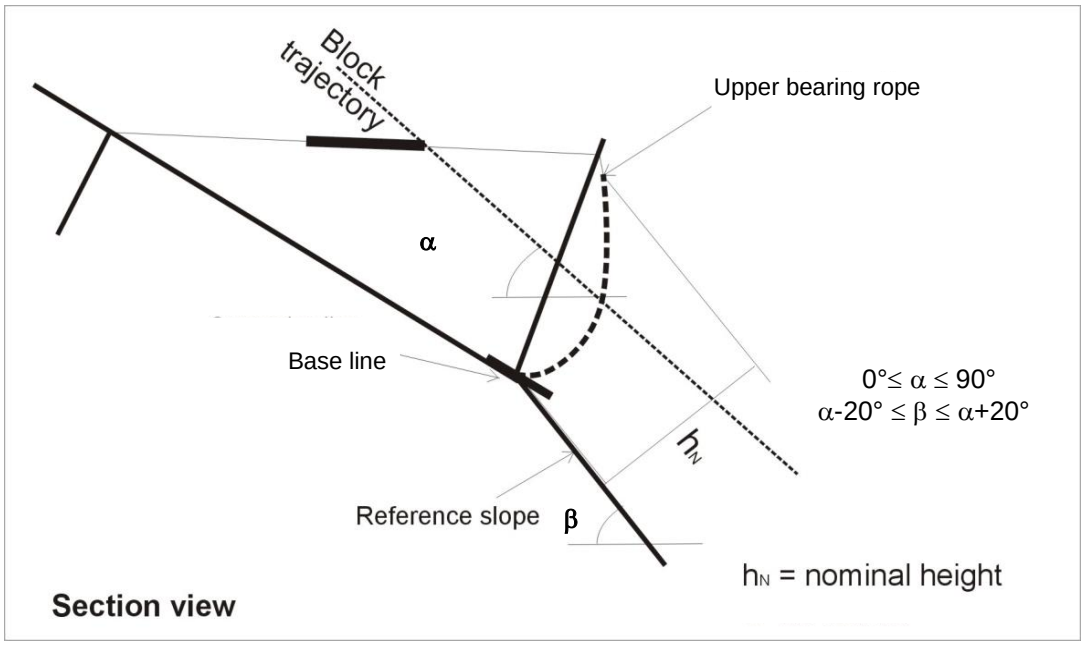

Figure A.1 – Test site slope

The test report shall include a description of the test site.

A.2 Test equipment

Kit installation

Three functional modules as defined in Clause 1.1 of this EAD shall be used for the tests. Installation geometry and kit assembly to be assessed are subjects of agreement between Technical Assessment Body and manufacturer.

The foundation design is subject of agreement between Technical Assessment Body and Manufacturer, even it is not part of the kit to be assessed.

Technical Assessment Body checks the installed test specimen (tested kit).

The following information on the kit to be tested shall be included in the test report and given in the ETA:

Geometry of the assembled kit:

Sketches

- Frontal view

- Vertical cross section
- System drawings
- Sketches of details (i.e. base plate, connection of post/base plate, energy dissipating device etc.)

Description of components:

Support Structure (Posts, base plates)

- Material
- Dimensions

Interception structure

- Principal net
  - Description
  - Geometry
  - Diameter of wires/ropes/clamps etc.
  - Material
- Additional layer (if any)
  - Description
  - Geometry
  - Material

Connecting components

- Ropes
  - Number of ropes
  - Diameter
  - Positions
  - Designation
- Energy dissipating devices
  - Description
  - Number and types
  - Positions
  - Material
- Wire rope grips, clamps, shackles etc.
  - Description
  - Number (if relevant) and types
  - Positions
  - Material

The installed kit shall comply with this information given above and the test report shall include a confirmation of compliance.

The test report shall also include evaluation of corrosion protection of components in respect to its possible influence on the performance of the kit.

Block

The block is made of plain/reinforced concrete and its shape is the polyhedron defined in Figure A.2.

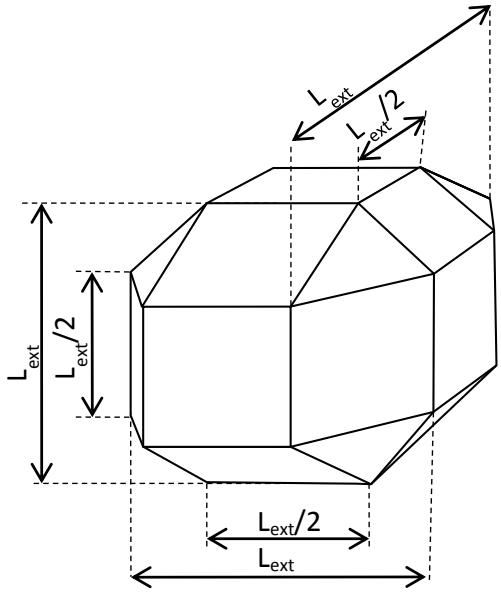

Figure A.2 – Shape of the block

The density of the block shall be between 2500 kg/m^3 and 3000 kg/m^3. In case of added steel elements, they shall be installed in a symmetric way to allow the coincidence between the centre of gravity and the geometrical centre of the block.

The maximum size of the block (L_{ext}) shall be lower or equal to 1/3 of the nominal height of the kit.

The block shall be released from launch system at least 1 metre before the impact.

The test report shall include description of the blocks used for both SEL and the MEL launch (mass, composition, density and coincidence between the centre of gravity and the geometrical centre of the block, dimensions as given in Figure A.2 and photos of the blocks before and after testing).

A.3 Test conditions

The trajectory of the block is inscribed in a vertical plane orthogonal to the base line of the falling rock protection kit. It can be inclined or vertical.

The mean speed of the block within the last 1 metre from the contact point with the net shall be greater than or equal to 25 m/s.

The test consists of the launching of blocks described in A.2 into the falling rock protection kit measuring the speed of the block before the impact and therefore determining the impact energy of the block. The value of the impact energy is equal to the kinetic energy of the block, given by:

$$E_c = \frac{1}{2} \cdot m \cdot V_{impact}^2$$

Where:

- V_{impact} is the mean speed of the impacting block evaluated in the last metre before the impact;
- m is the mass of the impacting block.

Note:

- Kinetic energy $E_c = \frac{1}{2} m v_{impact}^2 = mg\Delta h - W_f$
- V = initial speed = 0 m/s
- $\Delta h = Z_{impact} - Z_{initial}$
- Z_{impact} = elevation of the block at the time of the impact
- $Z_{initial}$ = elevation of the block in a static position immediately before the launch
- W_f = work of friction forces.

A.4 Test procedure

The test procedure is based on tests at two different energy levels: Service Energy Level (SEL) and Maximum Energy Level (MEL).

A.5 Service Energy Level (SEL) test

The Service Energy Level (SEL) test is carried out with two launches of a block into the falling rock protection kit with kinetic energy at both launches fulfilling the given energy absorption category according to Table 2.

Location of impact at SEL 1 launch: in the centre of the central functional module (see Figure A.3 and see also clause A.9 for accuracy).

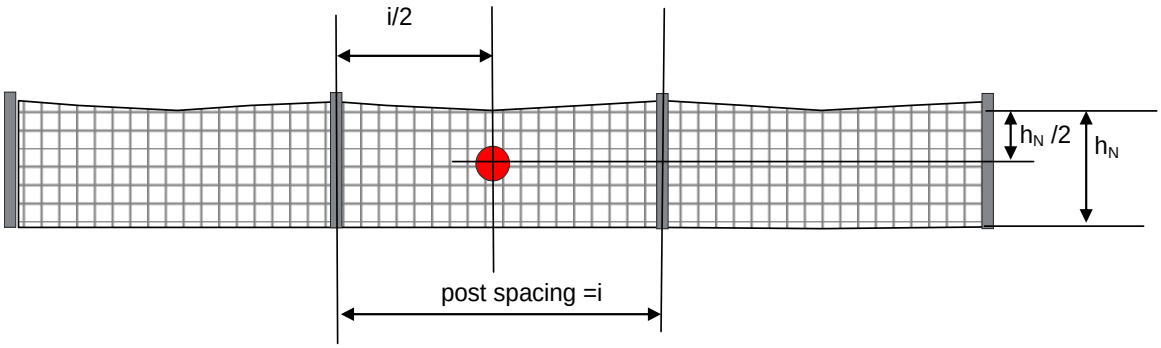

Figure A.3 – Location of impact at SEL 1 and MEL launches

The block is removed after the first launch.

Location of impact at SEL 2 launch: within the central functional module inside the residual height h_R of the kit which was obtained after the SEL 1 launch. The possible impact area of the centre of gravity of the block in SEL 2 launch is given in Figure A.4.

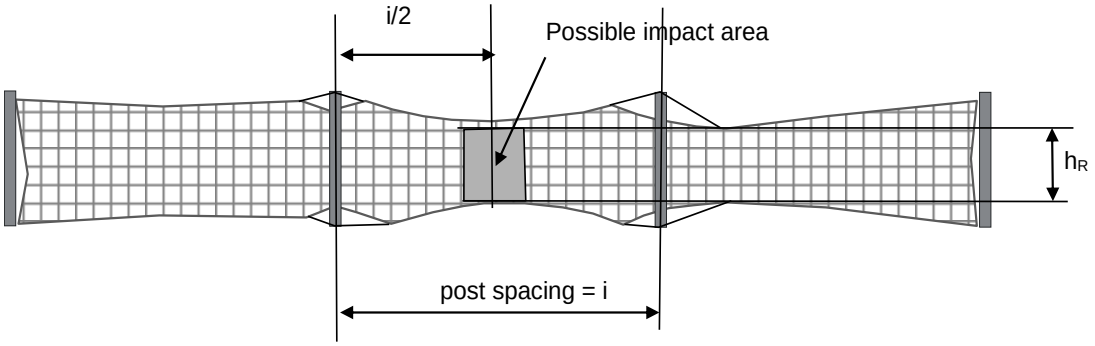

Figure A.4 – Location of impact at SEL 2 launch[7]

A.6 Maximum Energy Level (MEL) test

The test is carried out with one single launch of a block into the falling rock protection kit.

The MEL test may be carried out on the same kit used for SEL testing after being repaired or on a new one.

[7] The positions of the lower and upper longitudinal ropes are given only as examples.

The choice between these two options is subject of agreement between Technical Assessment Body and Manufacturer.

Location of impact at MEL launch: in the centre of the central functional module according to Figure A.3 (see also clause A.9 for accuracy).

A.7 Measurements of nominal and residual height, maximum elongation, lateral gaps

The nominal height h_N, as defined in clause 1.3.14, is measured orthogonally to the reference slope. The result of the measurement shall be rounded to the nearest centimetre.

The residual height h_R, as defined in clause 1.3.16, is measured orthogonally to the reference slope. The result of the measurement shall be rounded to the nearest centimetre. It shall be stated that the residual height for MEL and SEL 1 does not consider the lateral modules.

The maximum elongation, as defined in 1.3.15, is measured parallel to the reference slope. The result of the measurement shall be rounded to the nearest centimetre.

The lateral gap, as defined in clause 1.3.20, shall be measured in static conditions without removing the block from the net. At least one approach for the measurement of lateral gap according to 1.3.20 shall apply. The chosen approach, values and description shall be included in the test report and given in the ETA.

A.8 Recording test data

The following test characteristics shall be recorded, both for SEL and MEL tests and given in the test report:

Pre-test data:

- mass of the block,
- nominal height,
- photographic records of the position and construction of the falling rock protection kit (frontal and side view of the kit and system components),
- geometric parameters of the falling rock protection kit (according to Clause A.2 and additionally the height and inclination of support structure and length of functional module (posts spacing)),
- detailed geometrical survey (in projection on a plane parallel to the base line and normal to the reference slope for the SEL 1 and MEL) of the kit before the test, with edges of the interception structure,
- mechanical, geometrical and material characteristics of components,
- confirmation about no maintenance done between SEL 1 and SEL 2 launches

Test data:

- impact speed,
- calculated impact energy according to A.3
- block trajectory:
    - effective trajectory of the block
    - location of impact
    - proof of block stopped

- maximum elongation of the kit (for SEL 2: including plastic deformation after SEL 1),
- photographic records to give a complete record of the kit behaviour, including deformation, deflections, braking time and proof of no ground contact before the maximum elongation to be reached,
- forces acting on the foundations,

Post test data:

- residual height (including indication on ratio between residual and nominal heights; for MEL and SEL 1 only),
- lateral gaps according to Clause 1.3.20 and 2.2.1.4 (for MEL and SEL 1 only),
- amount of activation (travel) of the energy dissipating devices
- description (if appropriate also with photographic records) of damage of the tested falling rock protection kit (for example ruptures, opening of the mesh, gaps between principal net and bearing ropes, mechanical fuses designed to break and how they operated, damages in posts and base plates etc.; for SEL 1 and MEL only)
- photos of the main components (posts, energy dissipating devices, principal net, etc.), frontal view and side view of the kit
- detailed geometrical survey (in projection on a plane parallel to the base line and normal to the reference slope) of the kit after the test, in static conditions without removing the block), with edges of the interception structure (for MEL and SEL 1 only).

Block speed measurements shall be evaluated from high-speed video records at a minimum of 100 frames per second or other equivalent devices (e.g. laser sensors) with at least the same accuracy and with adequate reference length.

Photographic or video cameras shall be sufficient to clearly describe the kit behaviour and block motion before and during the test.

At least one high-speed video camera is advised to be used for speed evaluation.

TAB and Manufacturer can agree the need for additional camera layouts in order to cover areas of special interest.

The test report shall include the installation scheme, evidence of accuracy/technical description and information on distortion of camera (horizontal/vertical) or adequate description in case of use of other device for the high-speed video camera (or equivalent devices, e.g. laser sensor) and technical description of additional video equipment (if used).

Force measurements on foundations and ropes shall be matter of agreement between TAB and Manufacturer and shall be adapted to the specific falling rock protection kit under test. At least 3 measurements shall be performed on main ropes linked to the central functional module. Measurement of the forces at the posts is to be considered as a case-by-case item: for kits with upslope ropes measurement of forces at the posts is normally not considered necessary (although it can be included in the ETA), while in case of specific design (e.g. if there are no upslope ropes), measurements at the posts may be necessary. In the ETA only values based on measurements (not on calculation inferred from theoretical formula) or vector sum of recorded loads on all the connection components loading the same foundation point have to be introduced. The recording of the force shall be at least 1000 measurements per second.

The forces shall be measured all the time during the time of impact.

The test report shall include the installation scheme, technical description and evidence of accuracy of the force measurement equipment.

Length measurements shall use topographic systems (non-contact optical measurements) or gauging tape. The maximum elongation shall be evaluated using high speed camera records or equivalent appropriate

devices.

The test report shall include technical description of the equipment used.

The mass and size of the block shall be measured before each test using an adequate dynamometer and gauging tape. A photo of the block shall be taken before and after the test.

The test report shall include technical description and evidence of accuracy of the dynamometer.

A.9 Accuracies and tolerances

The accuracy of the launch with reference to the geometrical impact point of the centre of gravity of the block in the test procedure is a one-metre diameter circle around the optimal impact point for the SEL 1 and MEL launches, that means that the trajectory of the centre of mass of the block has to pass through the tolerance circle as depicted in Figure A.5.

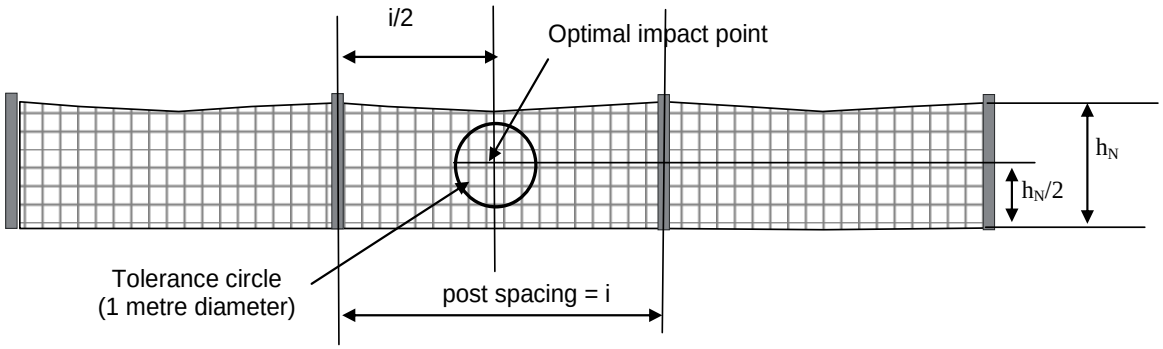

Figure A.5 – Tolerance for impact point for tests SEL1 and MEL

The minimum accuracy of the mass measurements shall be ± 3 %.

The overall accuracy of the speed measurements shall be ± 5 %.

The error margin on the energy is given from calculation based on actual accuracies on mass and speed measurements.

Force measurements shall be performed with devices that can fulfil the requirements for dynamic measurements; the accuracy shall be verified (for example, by means of calibration certificate issued by an appropriate accredited calibration body or another body accepted under the responsibility of the Technical Assessment Body). The verification of accuracy at the date of the test has to be done no more than one year previously.

In case of calibration certificates issued by an accredited calibration body the validity of the issued certificate applies.

All the lengths shall be measured with an accuracy of ± 1 % for static measures and ± 5 % for dynamic measures.

A tolerance of ± 5° is authorised for the impact angle between the foreseen trajectory and the effective trajectory of the block in the test site.

Effective accuracies and tolerances during testing shall be given in the test report.