FASTER, SAFER, SMARTER: MACCAFERRI ROCKFALL BARRIERS

MACCAFERRI

WEBINAR AGENDA

5’ Introduction

10’ Standards available

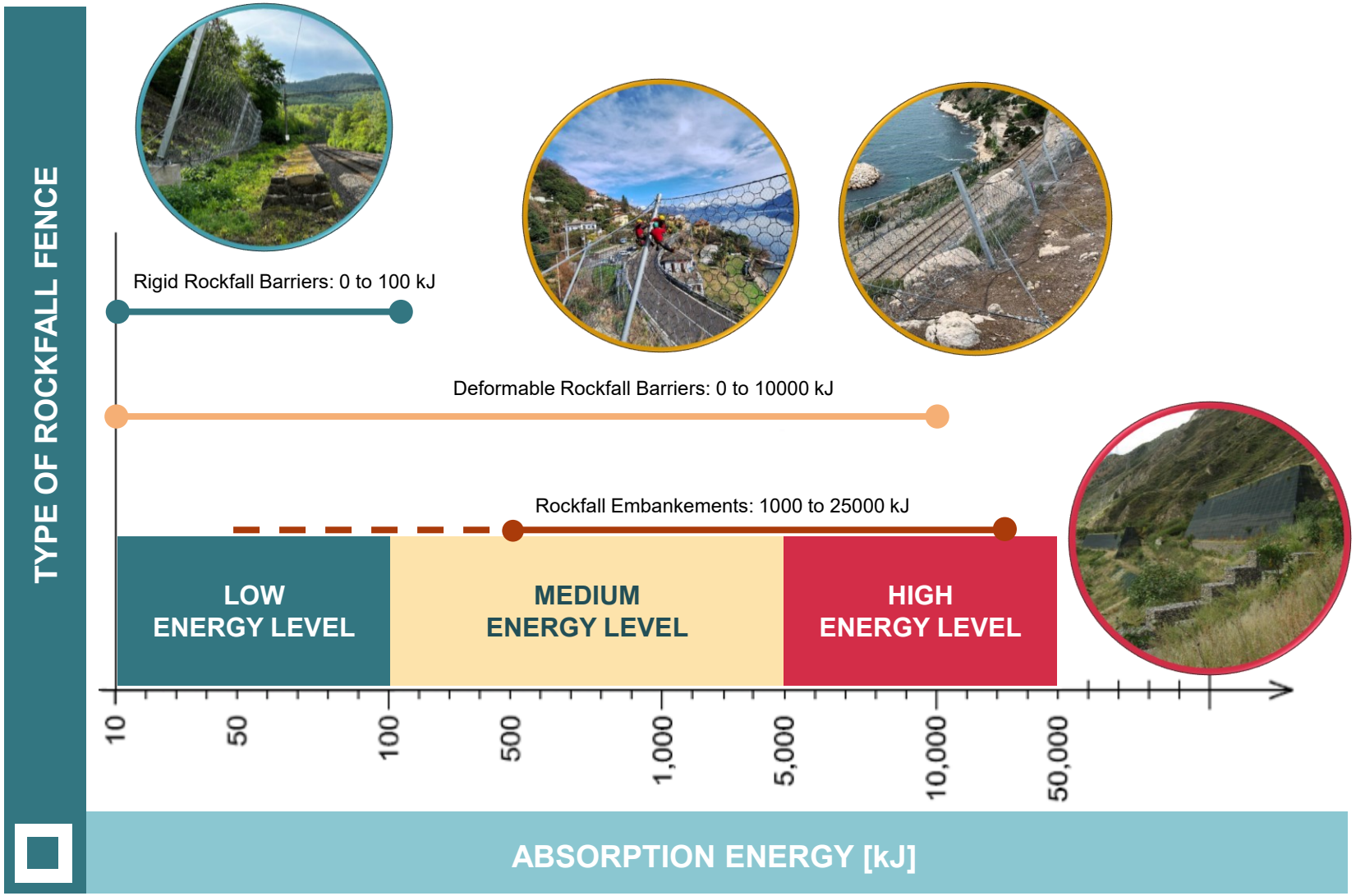
20’ Maccaferri portfolio

5’ Conclusions

Live Q&A Session

Speaker: ***Luca Gobbin*** − *Corporate Technical Specialist*

PASSIVE ROCKFALL PROTECTION SYSTEMS



TO BETTER UNDERSTAND KILOJOULES

MACCAFERRI

Considering a reinforced concrete sphere (2,500 kg/m^3)

Kilo-Joules	Weight	Speed	Diameter	Analogy
100 kJ	~ 259 kg	100 km/h	0.58 m	
500 kJ	~ 1,330 kg	100 km/h	1.00 m	
1,000 kJ	~ 2,600 kg	100 km/h	1.26 m	
3,000 kJ	~ 7,800 kg	100 km/h	1.81 m	
9,000 kJ	~ 23,500 kg	100 km/h	2.56 m	
25,000 kJ	~ 64,800 kg	100 km/h	3.67 m	

KEYPOINTS

MACCAFERRI

1 WHAT'S A RKF BARRIER?

2 STANDARDS AVAILABLE

3 EAD 340059-00-0106

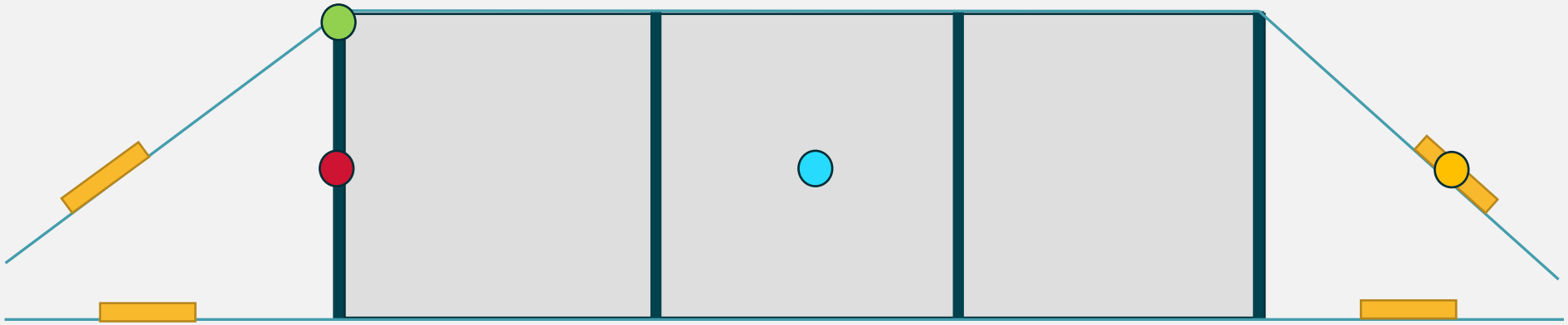
4 EAD 340089-00-0106

5 MACCAFERRI PORTFOLIO

1 WHAT'S A RKF BARRIER?

WHAT'S A RKF BARRIER ?

The main parts of a rockfall barrier are:
posts, ropes, interception structure (and brakes)



ENTE ITALIANO DI NORMAZIONE

PAR EUROVENT CERTITA CERTIFICATION NF

EUROPEAN STANDARDS

ISO International Organization for Standardization

CE "Conformité Européenne"

2 STANDARDS AVAILABLE

STANDARDS AVAILABLE

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PRODUCT STANDARDS

These define the products, their characteristics, the performances they must have and how these performance have to be assessed.

They are related to the products.

- 1996 Norme Française (NF P 95-308)
- 2001 Swiss Guideline (Gerber-UFAFP & WSL)
- 2003 US recommendations (AASHTO)
- 2005 (2002): Austrian Guideline (WLV)
- 2008 European Technical Approval (ETAG 027**)**
- **2018 European Assessment Document (EAD 340059-00-0106)**
- **(2019) European Assessment Document (EAD 340089-00-0106)**

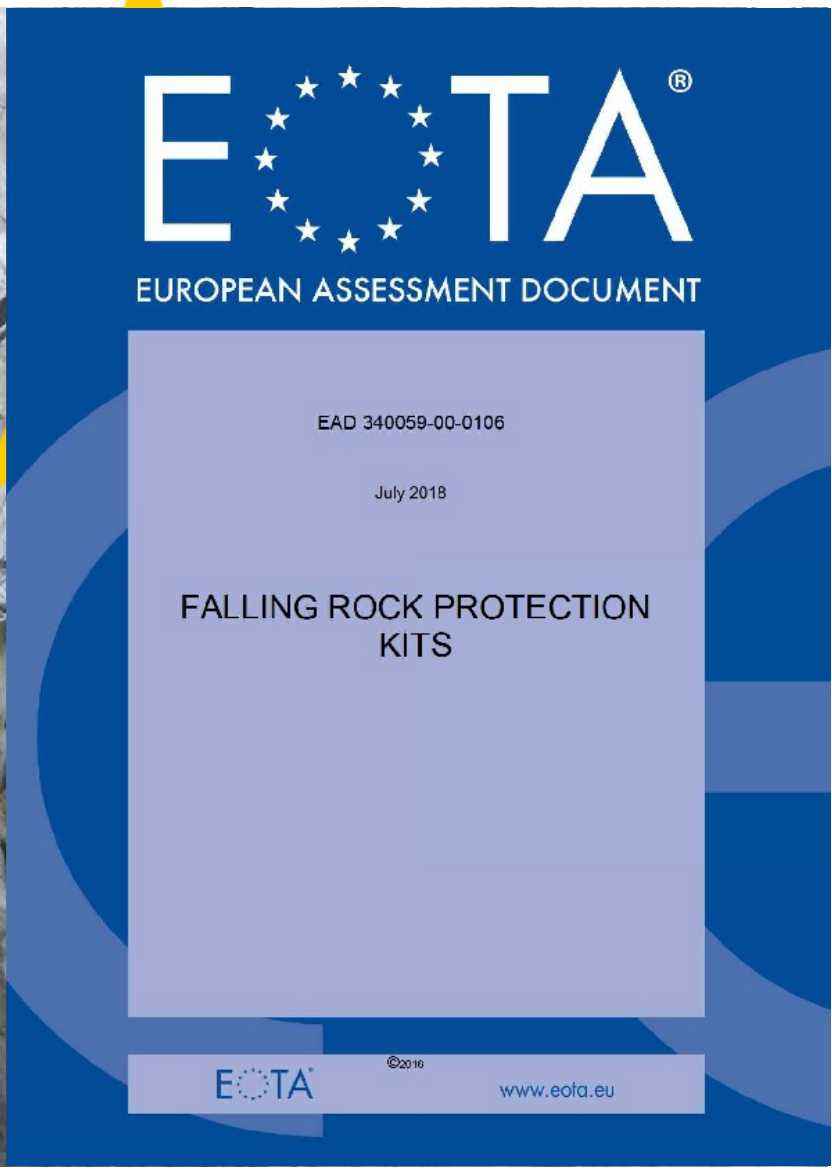
DESIGN STANDARDS

These define how to approach a problem and how to design (engineering meaning) a solution.

They are oriented to designers.

- 2018 Italian Norm (UNI 11211-4)
- 2013 Austrian Norm (ONR 24810)
- 2013 New Zealand Technical Guideline (Christchurch City Council)
- 2014 French recommendations (CEREMA)

3 EAD 340059-00-0106



European Organisation for Technical Assessment

European Organisation for Technical Approvals

EAD 340059-00-0106 (EX ETAG 027) GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL OF FALLING ROCK PROTECTION KITS – 2008 (rev. 2018)

1. Defines the methodology to carry out the **Full-Scale Crash Tests**
2. Defines the **controls on the production and materials**

ETA (European Technical Approval) & CE MARKING

EAD 340059-00-0106 - ENERGY CLASSIFICATION

MACCAFERRI

THE STANDARD DEFINES **TWO ENERGY LEVELS** FOR THE BARRIERS, SPECIFYING THE RATIO BETWEEN THEM.

FALLING ROCK PROTECTION KIT CLASSES

ENERGY LEVEL CLASSIFICATION	0	1	2	3	4	5	6	7	8
SEL	-	85	170	330	500	660	1000	1500	>1500
MEL ≥	100	250	500	1000	1500	2000	3000	4500	>4500

EAD 340059-00-0106 - MEL

The **Maximum Energy Level (MEL)** is defined as the highest level of energy to which the barrier can withstand.
Actually, it is the minimum value for the **domain of resistance** of the barrier.

The **MEL** test is passed if:

- **The barrier stops the block**
- The block has not touched the ground before the barrier has reached its maximum elongation.

EAD 340059-00-0106 - SEL

The **Service Energy Level is equivalent at 1/3 of the MEL (for a 3000 kJ the SEL is 1000 kJ).**

The test consist in 2 launches without repairs between the two tests.

The **SEL** test is passed if:

- The residual height after the first test is greater than or equal to 70% of the nominal height.
- The barrier stops the block

EAD 340059-00-0106 – CRASH TEST

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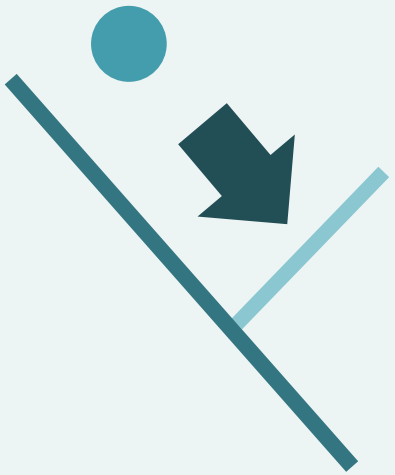
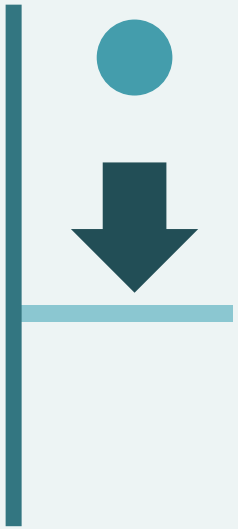
TEST SITE

INCLINED SLOPE

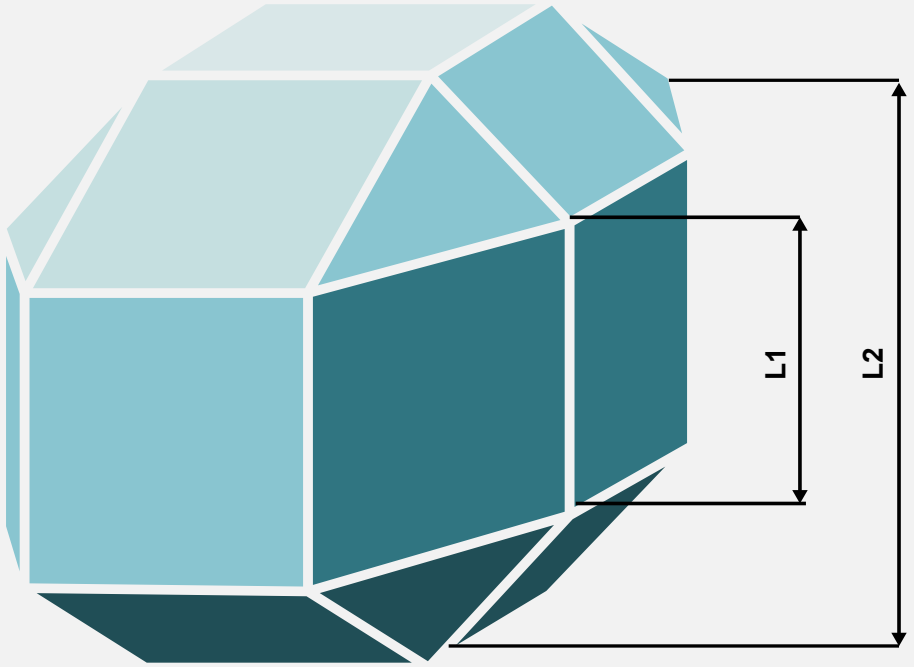


VERTICAL SLOPE



Impact velocity ≥ 25 m/s

BLOCK DIMENSION



Energy: $E_c = \frac{1}{2} \cdot m \cdot V^2$

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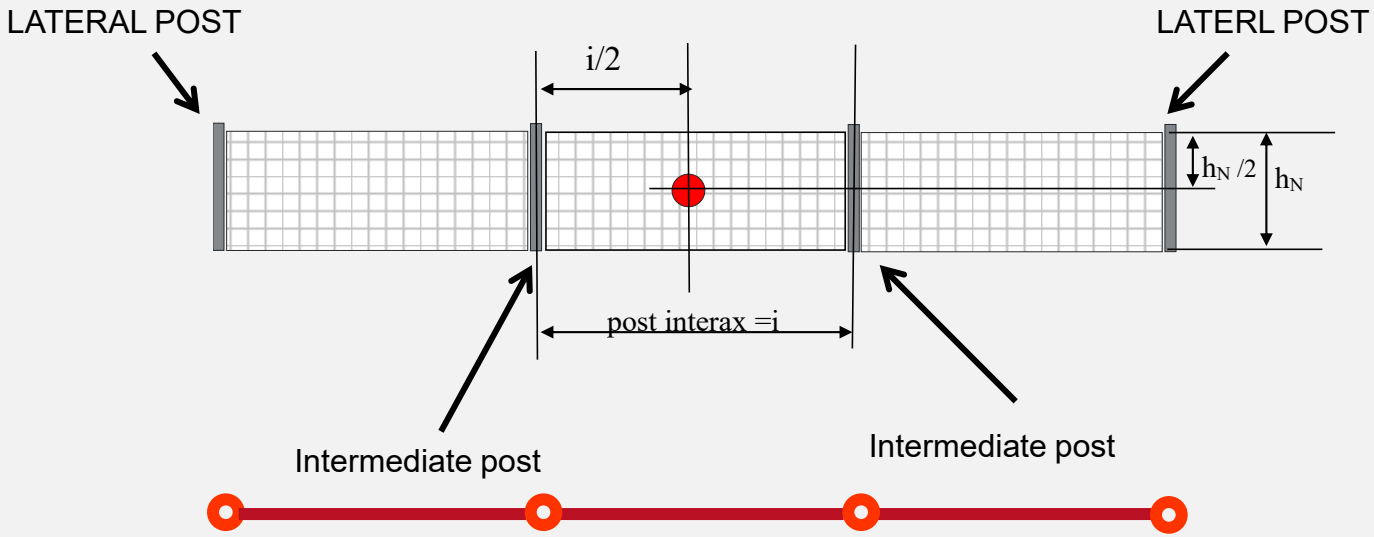
Barriers consist of n.4 posts (3 spans).

THE GUIDELINE DEFINES A MINIMUM BARRIER LENGTH.

Barrier configuration during the crash test

FRONT VIEW

PLAN VIEW



EAD 340059-00-0106 - GEOMETRICAL LIMITS

MACCAFERRI

AN IMPORTANT PART IS CHAPTER 1.1 WHERE LIMITS ARE DEFINED ABOUT THE ALLOWED GEOMETRICAL **CHANGES** TO THE TESTED KIT.

A reference height of the falling rock protection kit may be started 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 meter for a nominal height rounded to the nearest half meter superior or equal to 4 metres,

or

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

EAD 340059-00-0106 – FULL SCALE TESTS

EAD 340059-00-0106 – FULL SCALE TESTS

EAD 340059-00-0106 – FULL SCALE TESTS

EAD 340059-00-0106 - TEST EVALUATION

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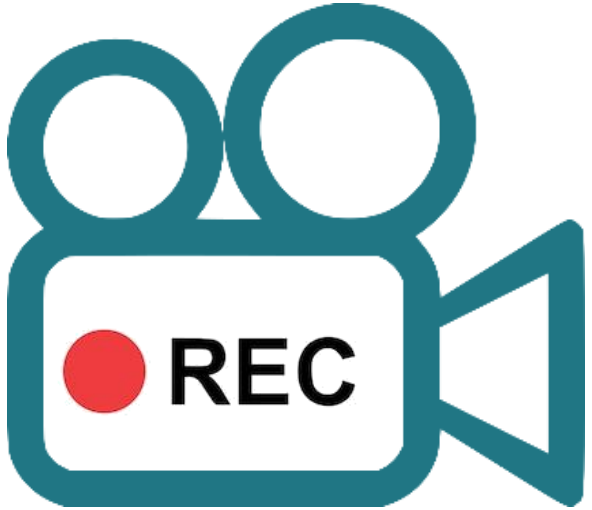
WHAT HAS TO BE RECORDED DURING A TEST?

- Elongation
- Residual height
- Lateral gap
- Actions acting on the anchors



EAD 340059-00-0106 - TEST EVALUATION

MACCAFERRI

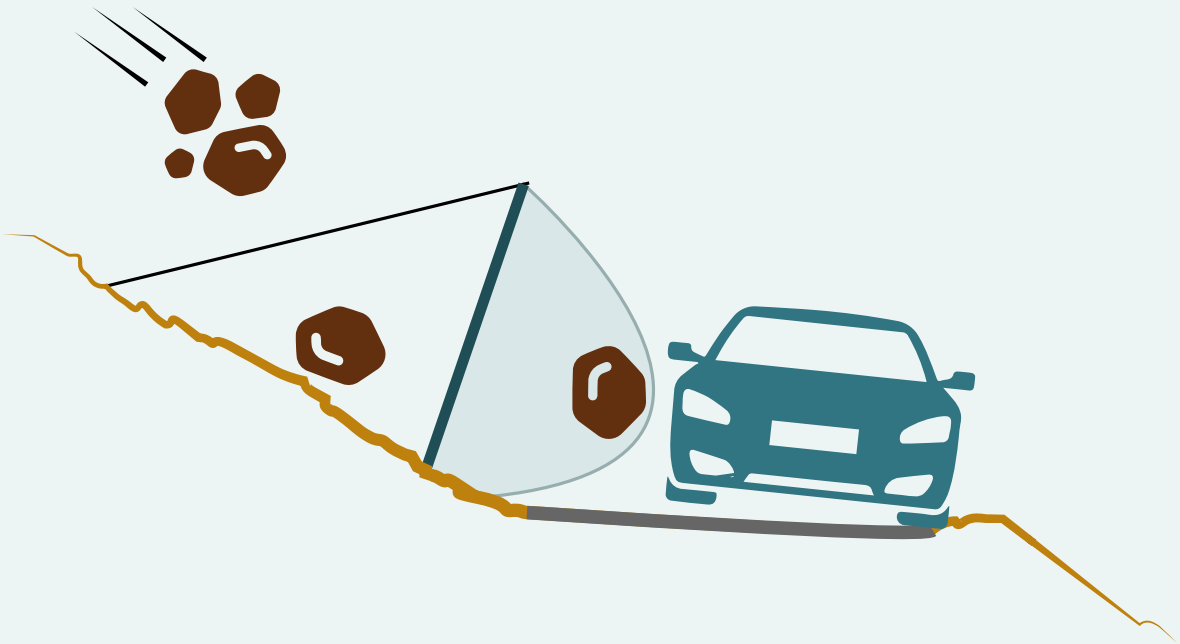
Table 1: Essential characteristics of the product and methods and criteria for assessing the performance of the product in relation to those essential characteristics

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

EAD 340059-00-0106 - ELONGATION

MACCAFERRI

THE MAXIMUM ELONGATION IS AN IMPORTANT ASPECT DURING THE DESIGN BECAUSE THE BARRIER CAN BE INSTALLED CLOSER TO THE PROTECTED AREA.



EAD 340059-00-0106 - RESIDUAL HEIGHT

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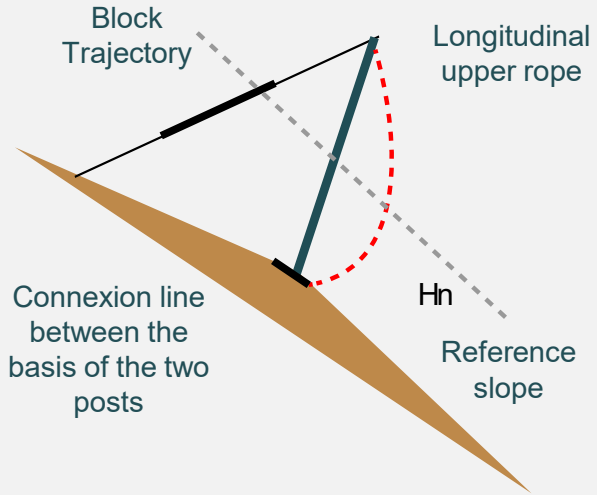
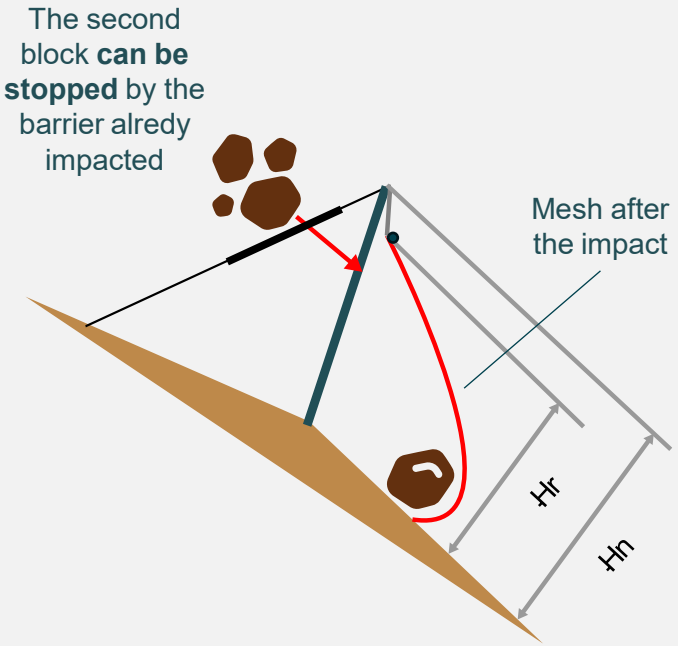
THE CATEGORY A ALLOWS TO HAVE A HIGHER SAFETY MARGIN IN CASE OF MULTIPLE IMPACTS AFTER THE FIRST.

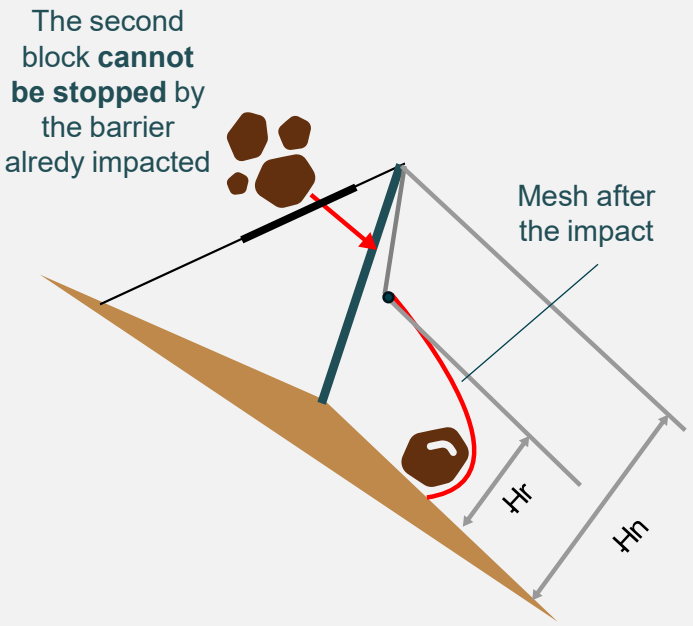


Hn = nominal height of the barrier

Nominal height of the barrier



High residual height:
Hr 75% (after impact)



Low residual height:
Hr 50% (after impact)

EAD 340059-00-0106 - RESIDUAL HEIGHT

- **Category A** residual height ≥ 50 % of the nominal
- **Category B** between 50% and 30% of the nominal
- **Category C**: residual height ≤ 30 % of the nominal

EAD 340059-00-0106 - LATERAL GAPS

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1.3.20 Lateral gaps of the assembled kit

The lateral gap can be defined either by:

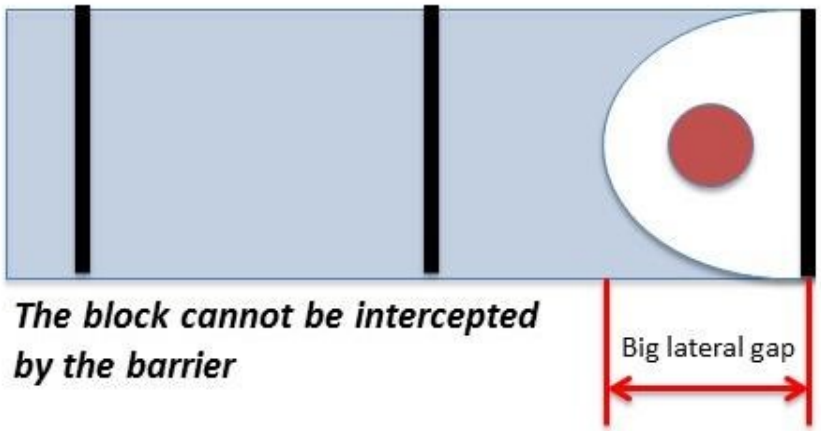
- maximum lateral displacement of the net (at outer post) from its initial position, measured parallel to the base line (approach 1),

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).

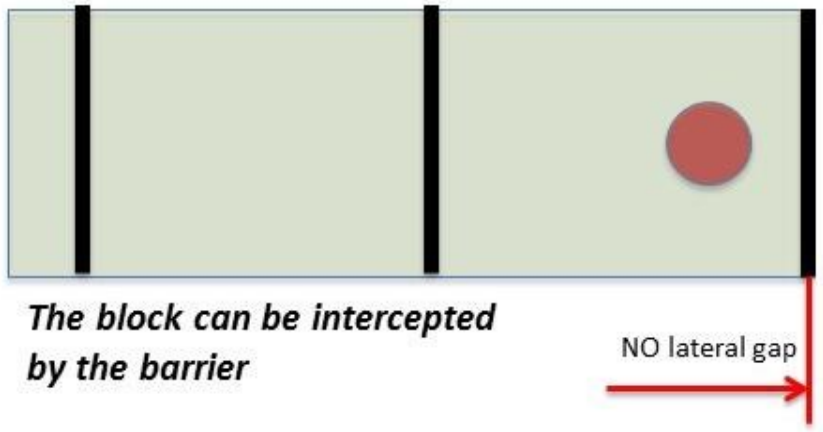
BARRIER N.1:

Length of the protected area ≠ Length of the barrier



BARRIER N.2:

Length of the protected area = Length of the barrier



EAD 340059-00-0106 - LATERAL GAPS

MACCAFERRI

The lateral gap is another important aspect during the design because the protected area and the length of the barrier are equivalent; thus, there's no need to add any extra lateral span (1 or 2 additional spans at the edge of the barriers).




EAD 340059-00-0106 - DURABILITY

Durability(*) – Chapter 1.2.2 of EAD :

- min. 25 years, in a standard environment (Cat. C2 – EN ISO 9223) ;
- min. 10 years, in an aggressive environment (Cat. C3 – EN ISO 9223) ;

Table C.1 — Description of typical atmospheric environments related to the estimation of corrosivity categories

Corrosivity category[a]	Corrosivity	Typical environments — Examples[b]	
		Indoor	Outdoor
C1	Very low	Heated spaces with low relative humidity and insignificant pollution, e.g. offices, schools, museums	Dry or cold zone, atmospheric environment with very low pollution and time of wetness, e.g. certain deserts, Central Arctic/Antarctica
C2	Low	Unheated spaces with varying temperature and relative humidity. Low frequency of condensation and low pollution, e.g. storage, sport halls	Temperate zone, atmospheric environment with low pollution (SO_2 < 5 µg/m^3), e.g. rural areas, small towns Dry or cold zone, atmospheric environment with short time of wetness, e.g. deserts, subarctic areas
C3	Medium	Spaces with moderate frequency of condensation and moderate pollution from production process, e.g. food-processing plants, laundries, breweries, dairies	Temperate zone, atmospheric environment with medium pollution (SO_2: 5 µg/m^3 to 30 µg/m^3) or some effect of chlorides, e.g. urban areas, coastal areas with low deposition of chlorides Subtropical and tropical zone, atmosphere with low pollution
C4	High	Spaces with high frequency of condensation and high pollution from production process, e.g. industrial processing plants, swimming pools	Temperate zone, atmospheric environment with high pollution (SO_2: 30 µg/m^3 to 90 µg/m^3) or substantial effect of chlorides, e.g. polluted urban areas, industrial areas, coastal areas without spray of salt water or, exposure to strong effect of de-icing salts Subtropical and tropical zone, atmosphere with medium pollution
C5	Very high	Spaces with very high frequency of condensation and/or with high pollution from production process, e.g. mines, caverns for industrial purposes, unventilated sheds in subtropical and tropical zones	Temperate and subtropical zone, atmospheric environment with very high pollution (SO_2: 90 µg/m^3 to 250 µg/m^3) and/or significant effect of chlorides, e.g. industrial areas, coastal areas, sheltered positions on coastline

(*)barriers without impacts (it cannot be excluded that in certain cases the lifespan is less than the one indicated).

EAD 340059-00-0106 - DURABILITY

Maccaferri coatings **GalMac C2** and **GalMac C3** ensure 50 year working life in C2 and C3 environment respectively.

GalMac C3 ensures 25 year working life in high aggressive environments as required by rockfall barrier standards

ETA CERTIFIED ROCKFALL BARRIERS

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4 EAD 340089-00-0106

LOW ENERGY IMPACTS

Even small debris can have a high disruption potential

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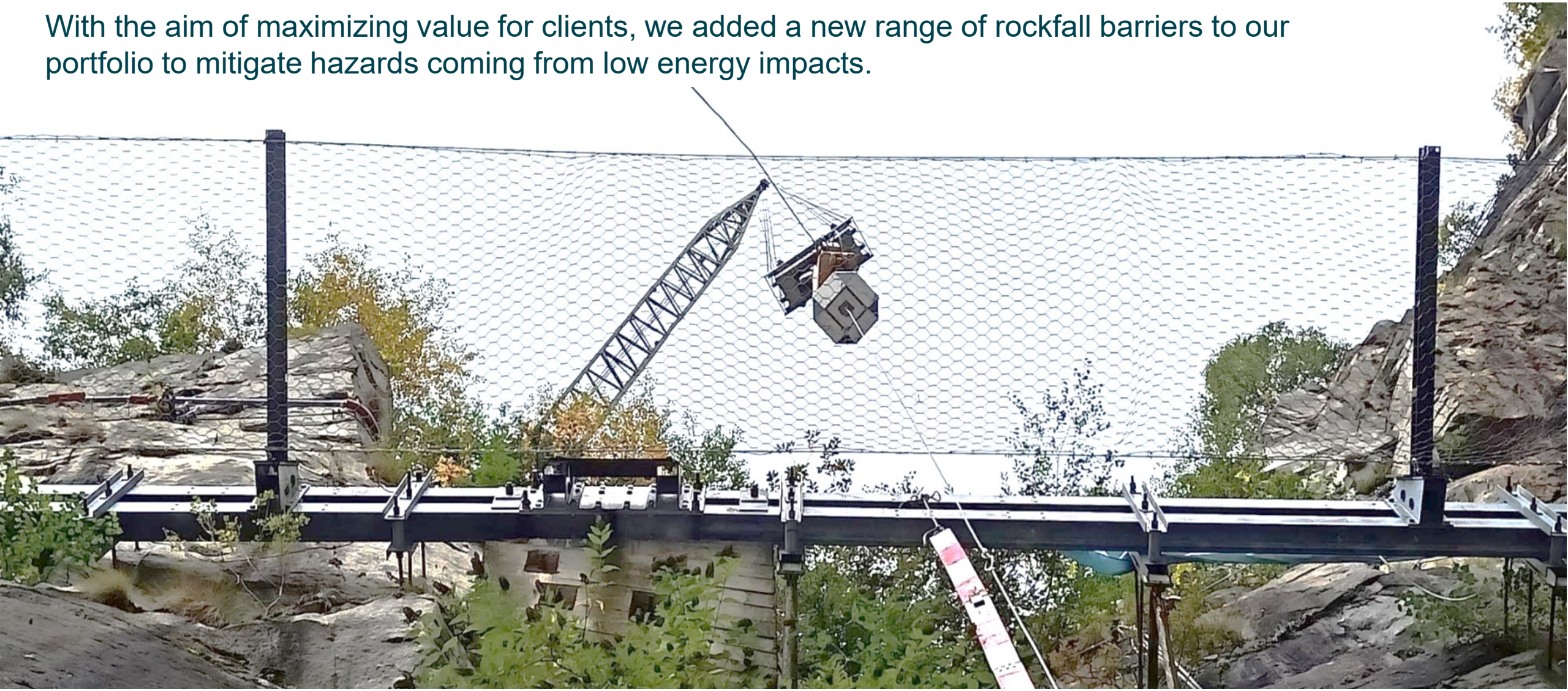
Rockfall hazards are not always related with the falling of big boulders. **For impact energy below 100 kJ**, traditional rockfall barriers are not a cost-effective solution.

OUR NEW RANGE OF ROCKFALL BARRIERS

MACCAFERRI

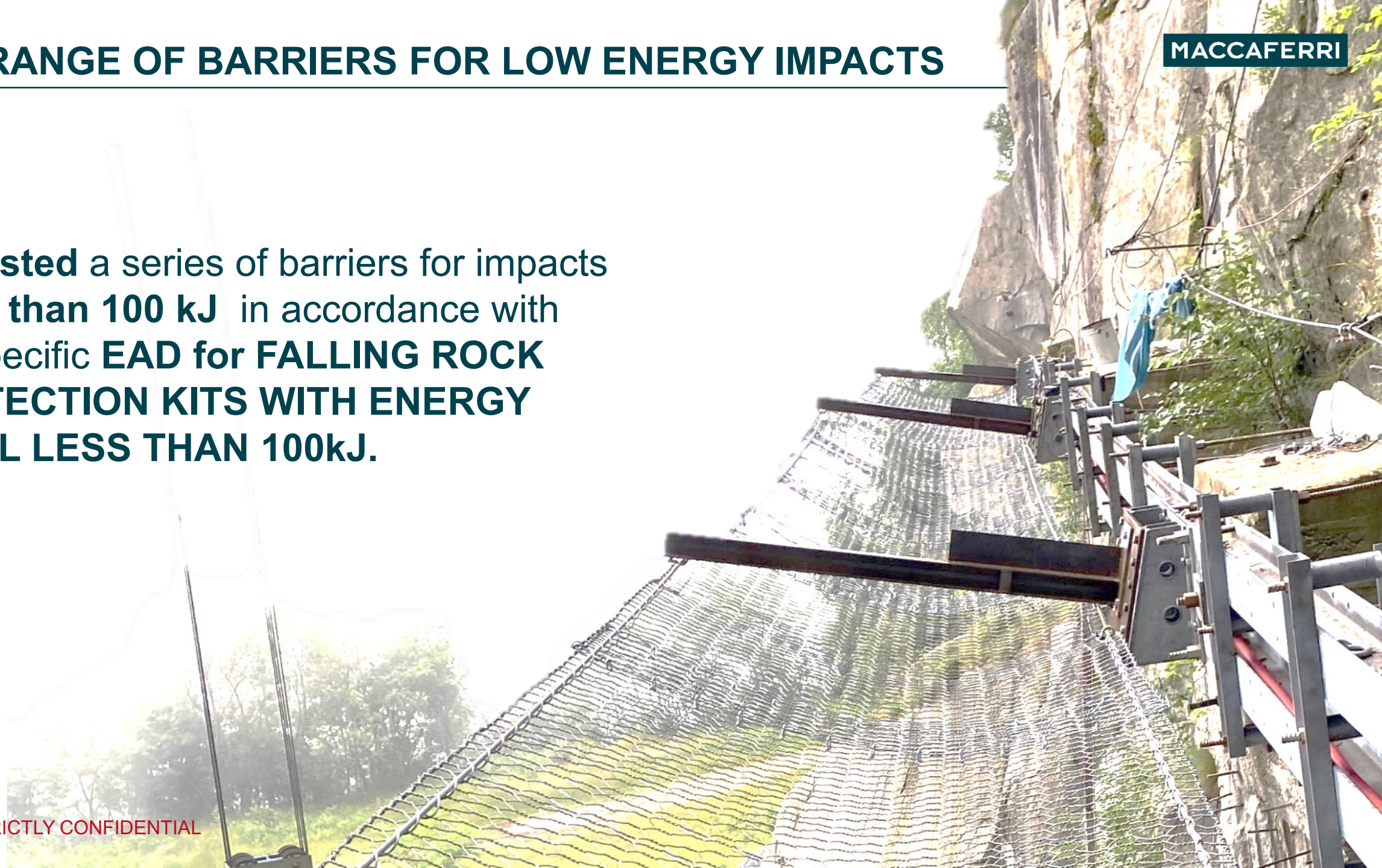
With the aim of maximizing value for clients, we added a new range of rockfall barriers to our portfolio to mitigate hazards coming from low energy impacts.



OUR RANGE OF BARRIERS FOR LOW ENERGY IMPACTS

MACCAFERRI

We tested a series of barriers for impacts **lower than 100 kJ** in accordance with the specific **EAD for FALLING ROCK PROTECTION KITS WITH ENERGY LEVEL LESS THAN 100kJ.**



TESTING PROCEDURE

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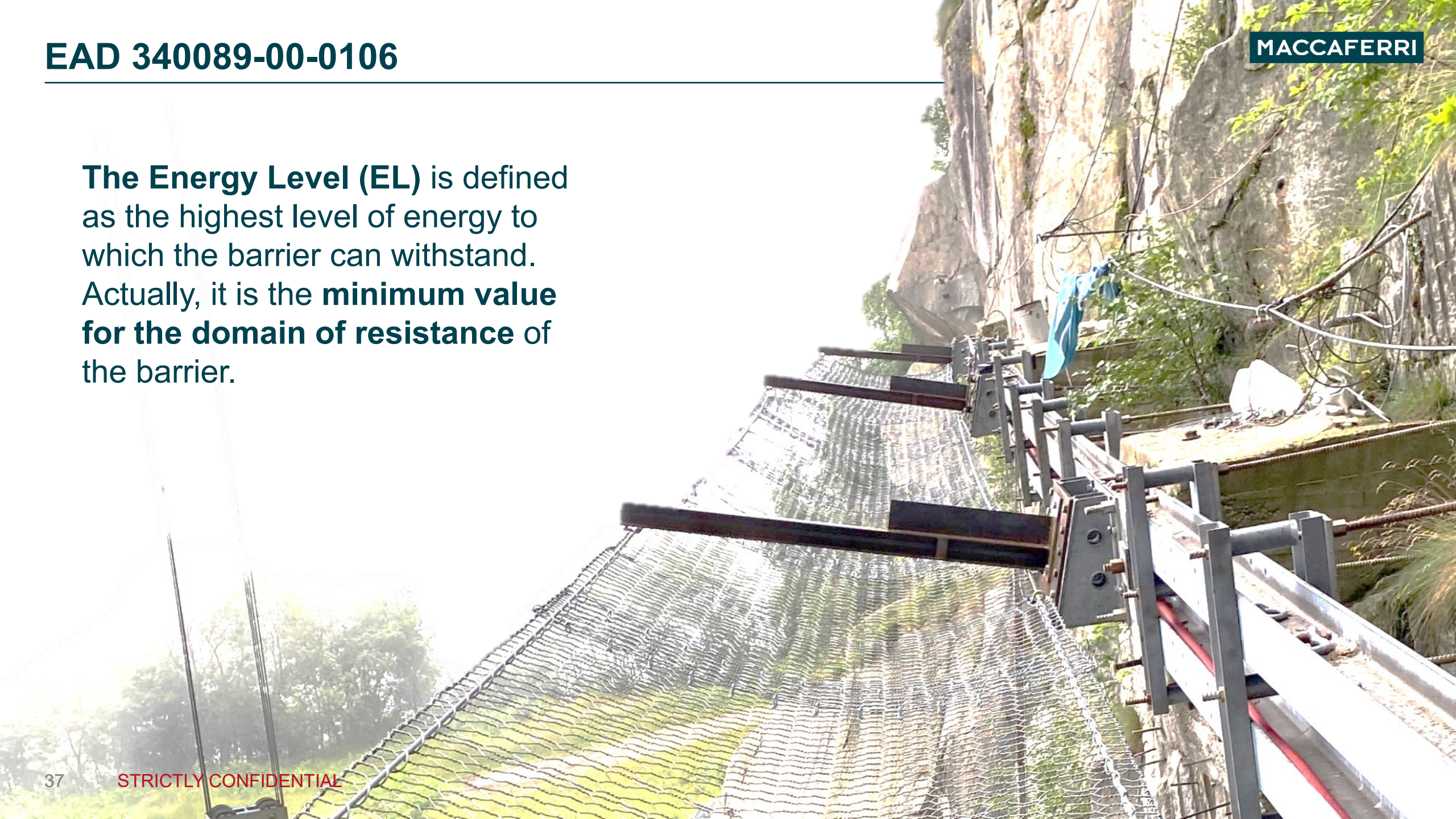
EAD 340089-00-0106 GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL OF FALLING ROCK PROTECTION KITS WITH ENERGY LEVEL (EL) LESS THAN 100 kJ – (rev. 2019)

1. Defines the methodology to carry out the **Full-Scale Crash Tests**
2. Defines the **controls on the production and materials**

ETA (European Technical Approval)

EAD 340089-00-0106

The Energy Level (EL) is defined as the highest level of energy to which the barrier can withstand. Actually, it is the **minimum value for the domain of resistance** of the barrier.

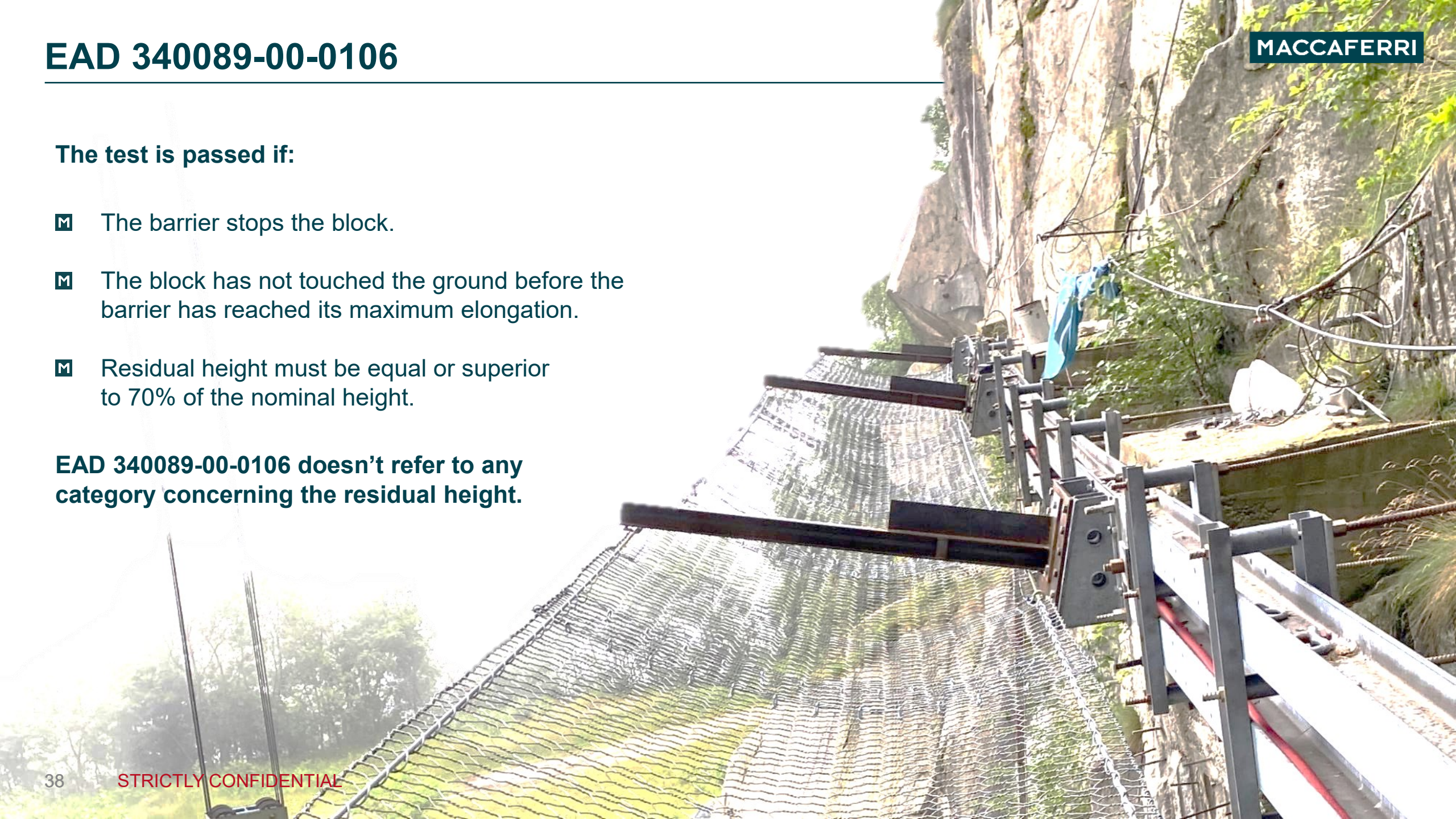


EAD 340089-00-0106

The test is passed if:

- The barrier stops the block.
- The block has not touched the ground before the barrier has reached its maximum elongation.
- Residual height must be equal or superior to 70% of the nominal height.

EAD 340089-00-0106 doesn’t refer to any category concerning the residual height.



EAD < 100kJ vs EAD ≥ 100 kJ

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WHAT CHANGES?

EAD 340089-00-0106

- ENERGY LEVEL (EL)
- NOT SEL 1
- NOT SEL 2
- NOT CATEOGORIES FOR RESIDUAL HEIGHT

EAD 340059-00-0106 (EX ETAG 027)

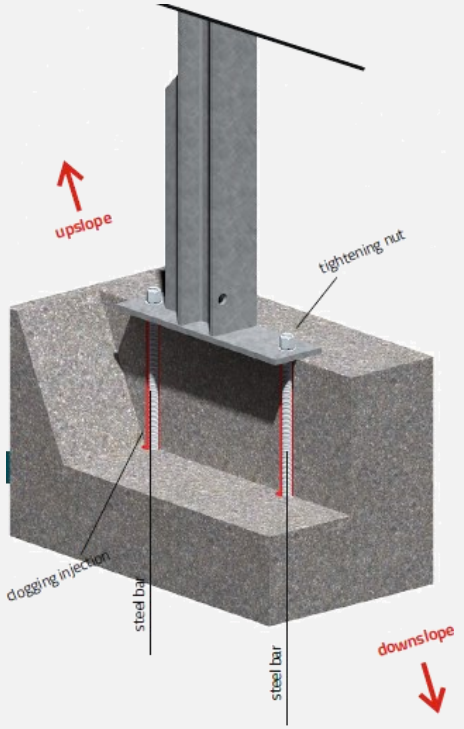
- MEL
- SEL 1
- SEL 2
- RESIDUAL HEIGHT CATEGORY (MEL)

MACCAFERRI LOW ENERGY BARRIERS - PORTFOLIO

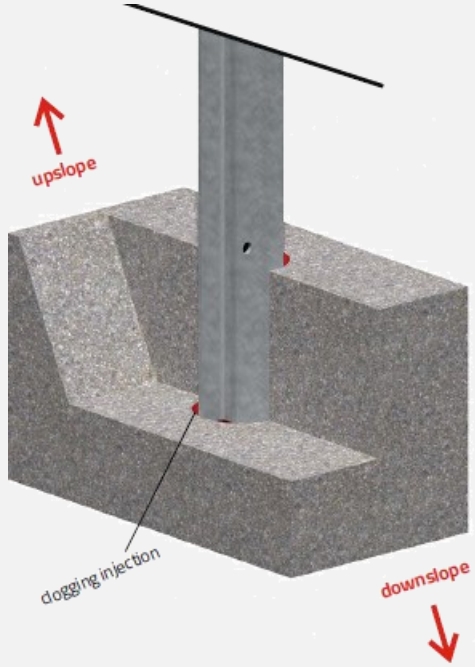
MACCAFERRI

RB 35, RB 35 H2 AND RB 70 ARE AVAILABLE IN 3 CONFIGURATIONS:

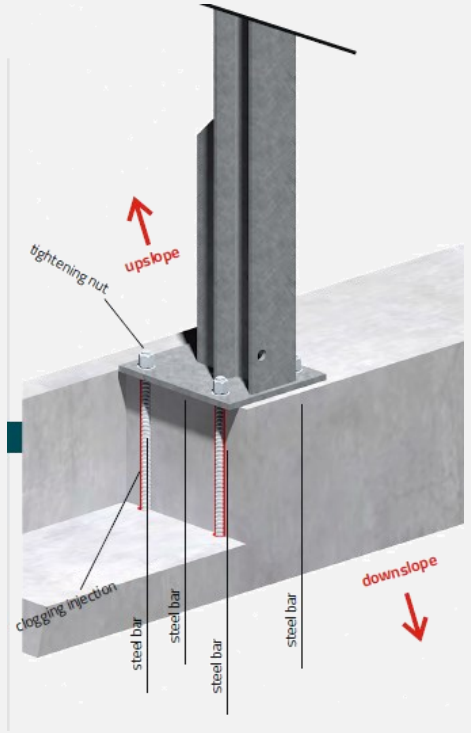
Standard configuration:
with 2 anchors
(for soil or rock)



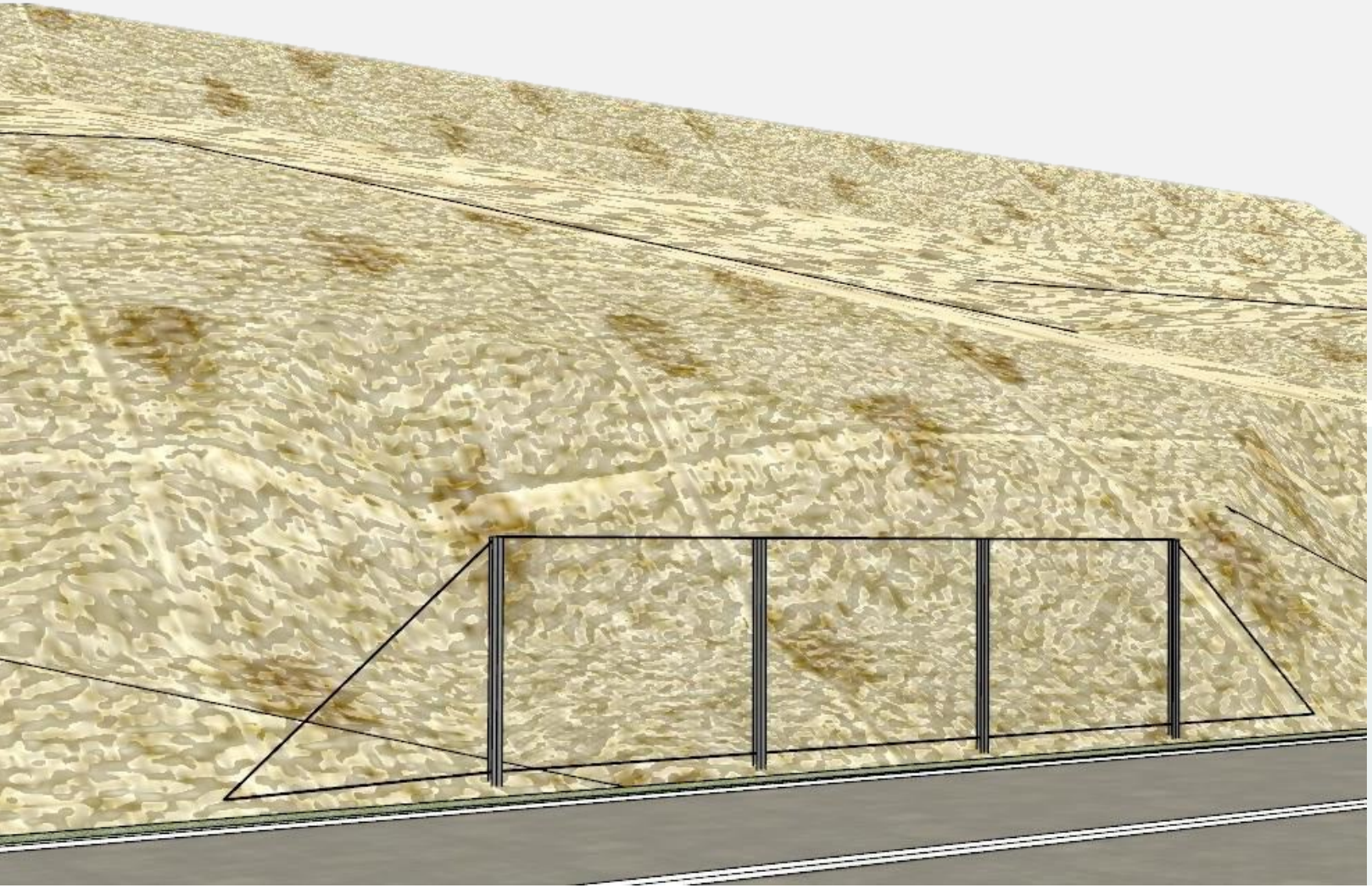
NP configuration:
no plate at the base of the post
(for soil or rock)

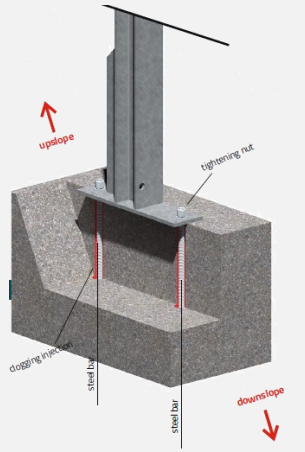


CW configuration:
with 4 anchors
(for concrete wall)



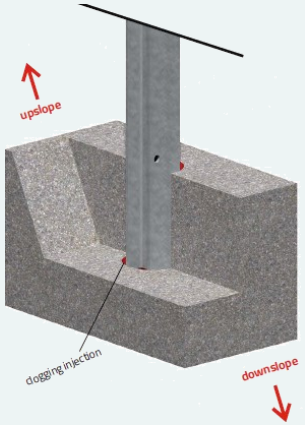
MACCAFERRI LOW ENERGY BARRIERS - ANCHORS





Standard configuration:

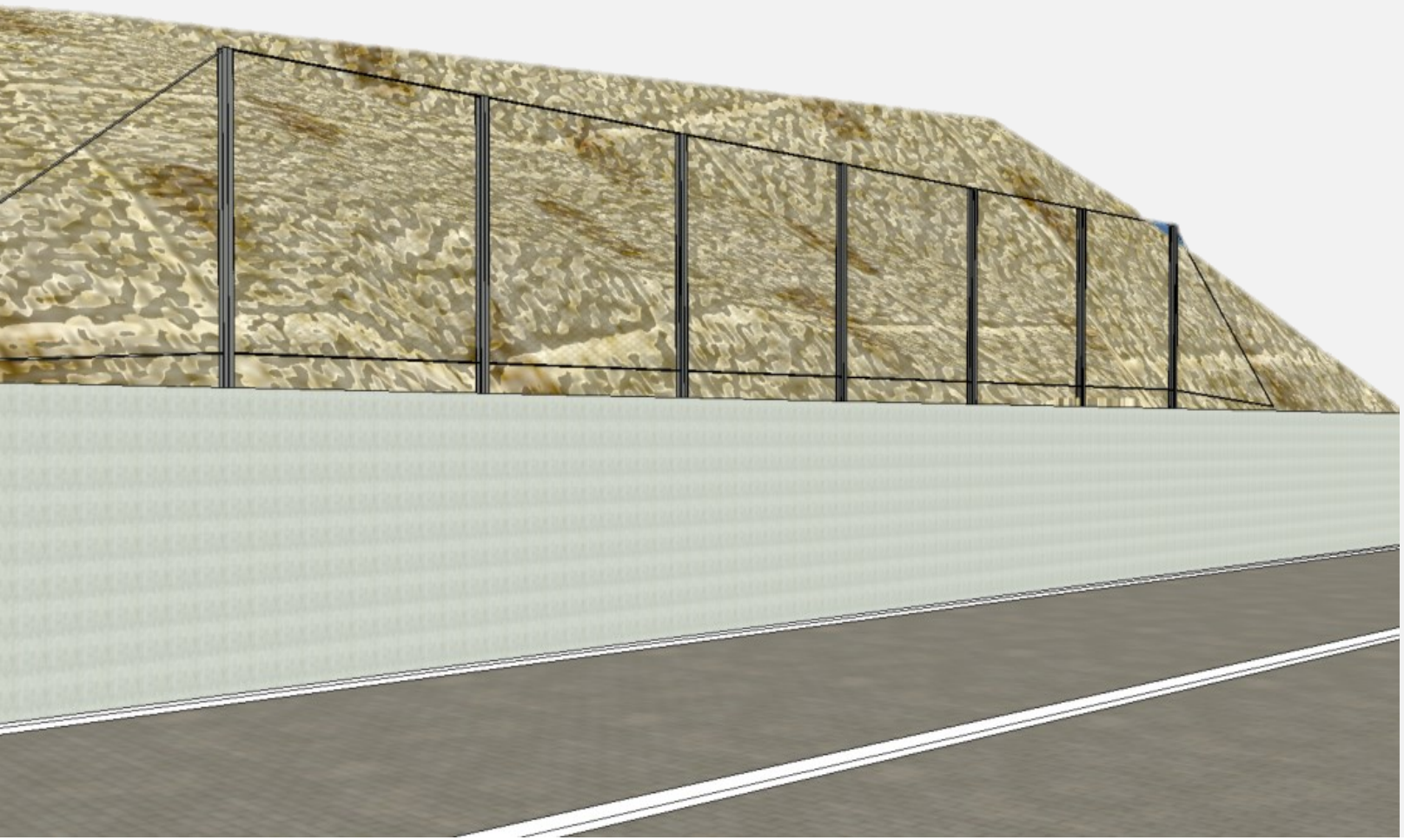
with 2 anchors
(for soil or rock)



NP configuration:

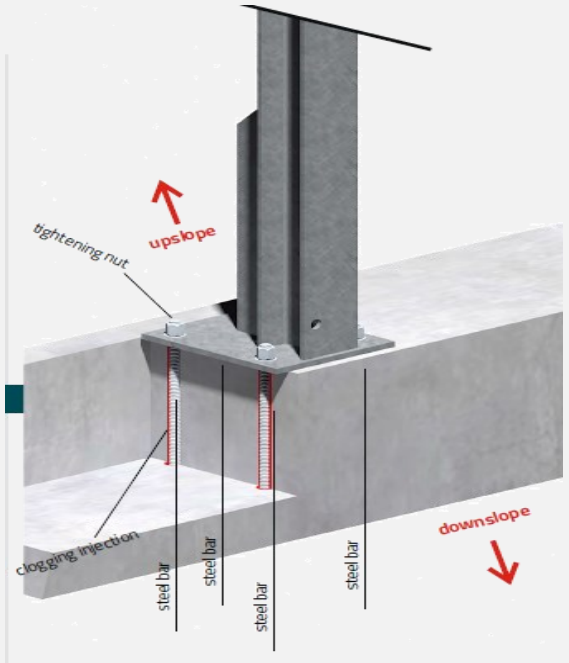
no plate at the base of the post (for soil or rock)

MACCAFERRI LOW ENERGY BARRIERS - ANCHORS

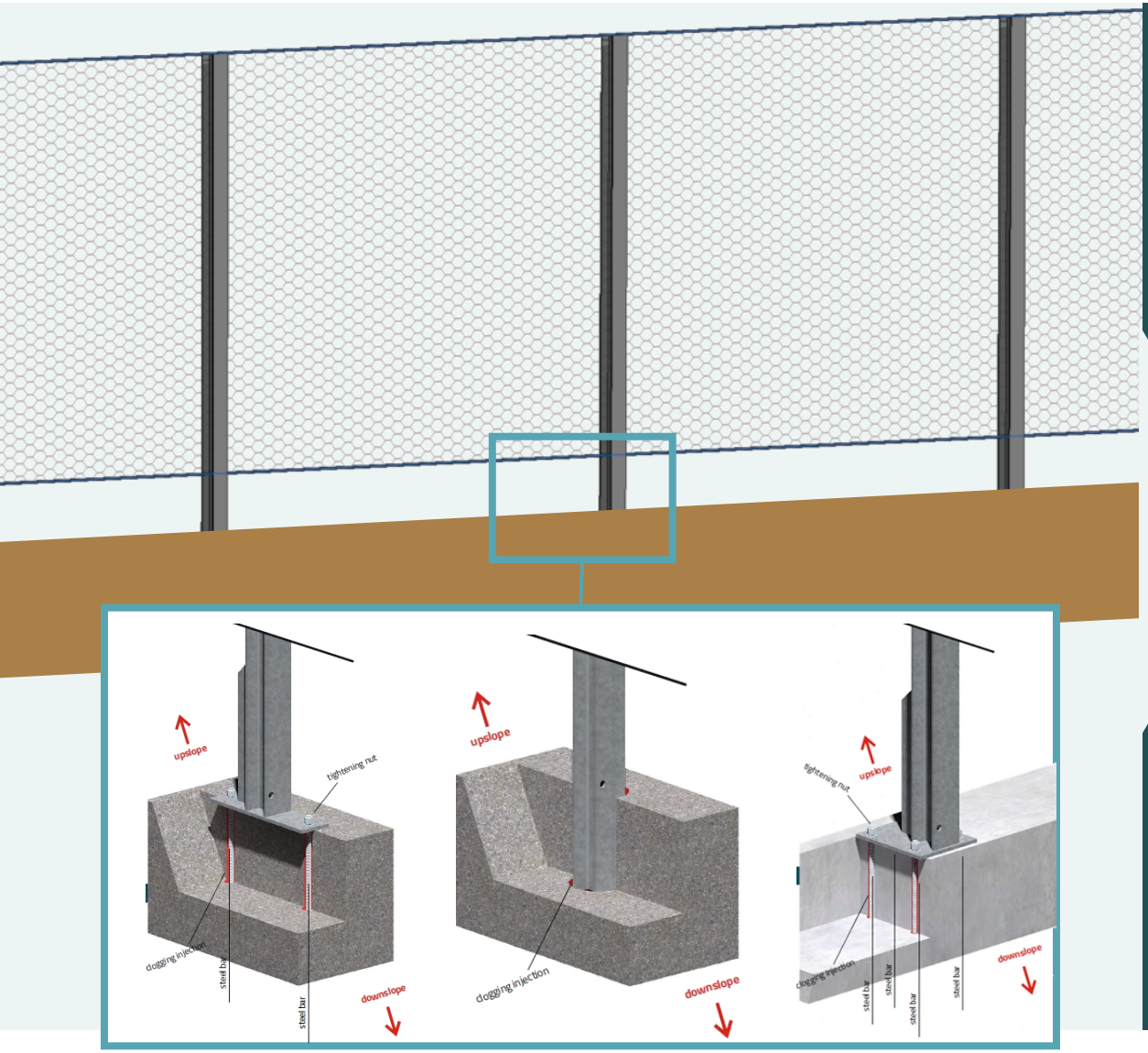


CW configuration:

with 4 anchors (for concrete wall)



DESIGN OPTIONS



LESS DRILLING

Foundations are an **economical fundamental aspect** during the **installation.**

Contractors look carefully at number and length of upslope, lateral & post anchors. Maccaferri low energy barriers have been **designed to provide a wide range of configurations** for anchoring the barriers (Standard, NP, CW) for **saving drilling operations costs.**

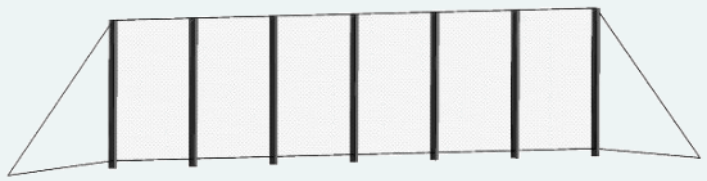
5 MACCAFERRI PORTFOLIO

MACCAFERRI ROCKFALL BARRIER PORTFOLIO

MACCAFERRI

Portfolio integration and enhancements

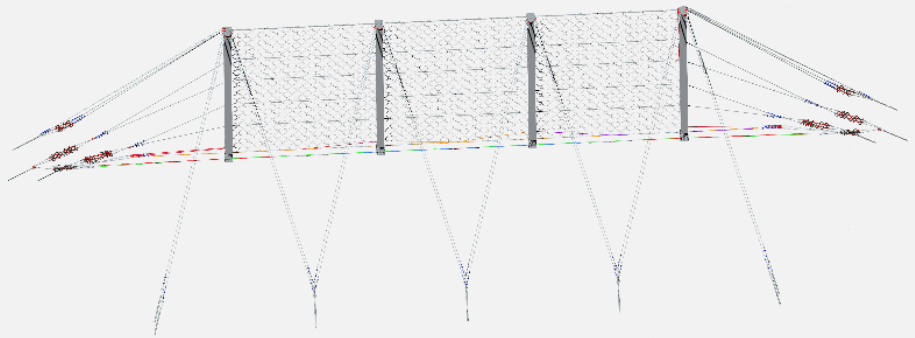
LOW ENERGY BARRIERS
EAD 340089-00-0106



- RB 35
- RB 35 H2
- RB 70

HIGH ENERGY BARRIERS
EAD 340059-00-0106

100 kJ



- RB 100-UAF
- RB1000
- RB 2000
- RB 2000 H4
- RB 9000
- RB 750
- RB 1500
- RB 2000 H6
- RB 3000
- EPFM 5000

OUR SUCCESS STORIES

MACCAFERRI

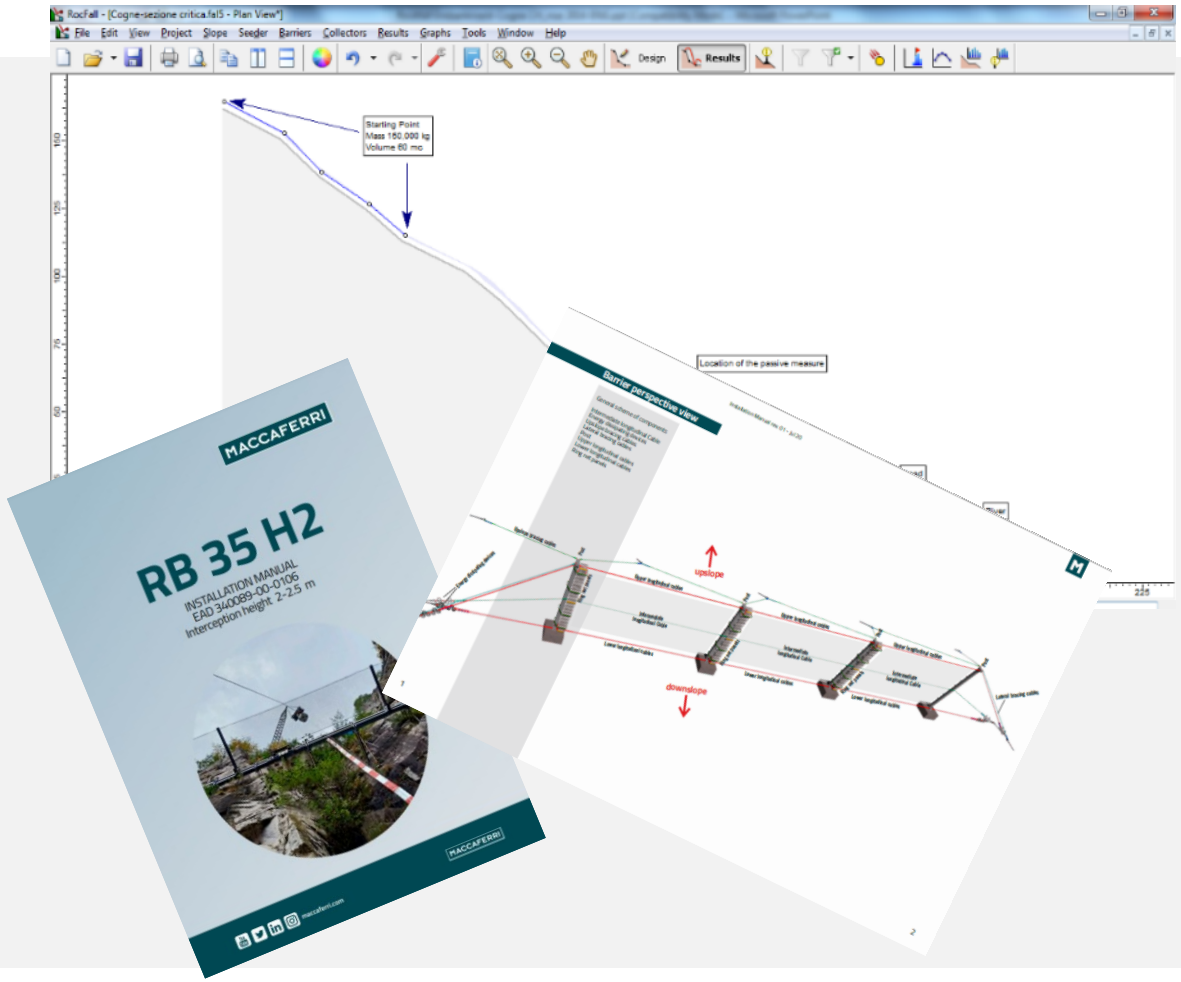
Oggebbio, VCO (Italy)

OUR SUCCESS STORIES

MACCAFERRI

Gorges du Creuset (38), France

TECHNICAL SUPPORT

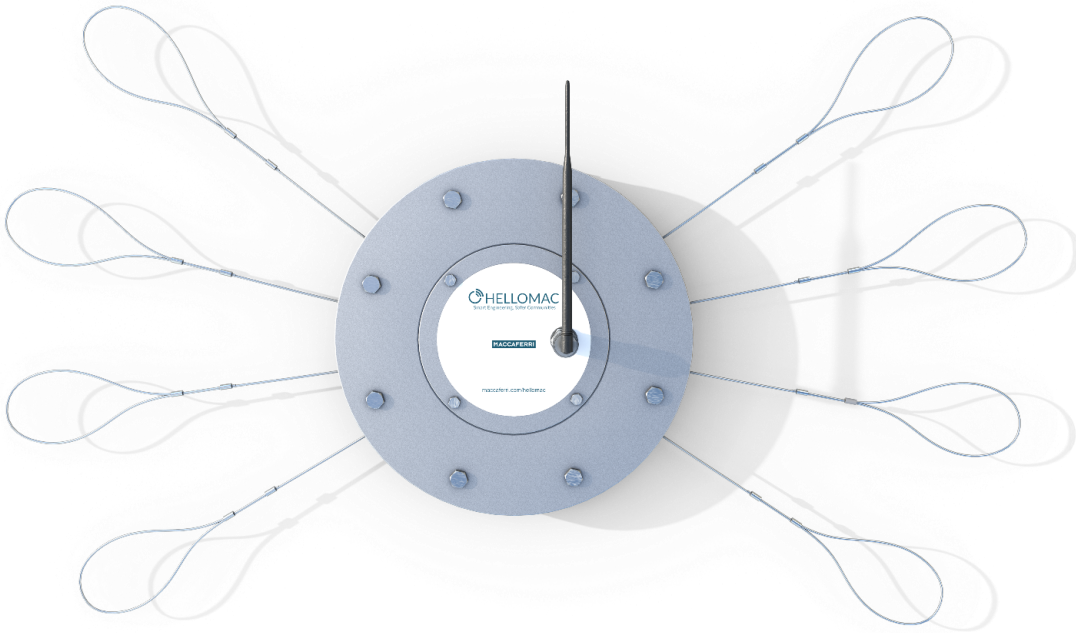


Choosing Maccaferri barriers means having a **specialized support** during all the project phases:

Design (choice of the barrier)
Installation support (staking out)
Certificate of correct installation &
Maintenance guide

SMART ROCKFALL BARRIERS

SMART ROCKFALL BARRIERS



SMART ROCKFALL BARRIERS

MACCAFERRI

Thank you for your attention!

Any questions?

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Grazie per l’attenzione!

Domande?

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