



SNOW AVALANCHE SAFETY: RISK MITIGATION INNOVATIONS

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5' Introduction

20' Maccaferri Sow Portfolio

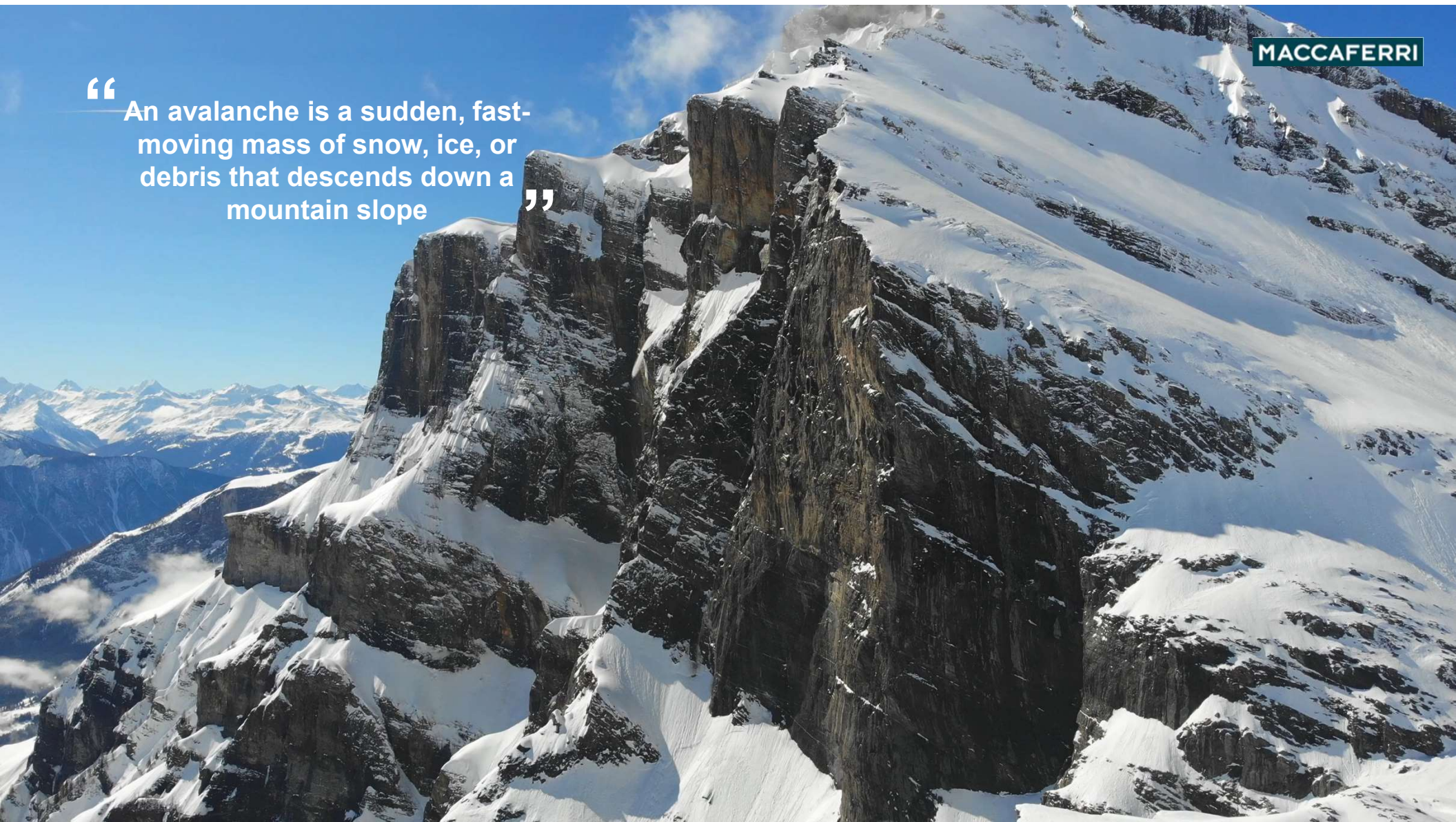
10' Technical Support

5' Advanced monitoring

Live Q&A Session

Speaker: *Luca Gobbin – Corporate Technical Specialist*

“An avalanche is a sudden, fast-moving mass of snow, ice, or debris that descends down a mountain slope”



What triggers an avalanche?



Gravity > Frictional Forces





Once the **equilibrium of the forces** inside the snowpack is **broken**, the mass of snow begins **to slide downslope**.

The movement of the snow mass begins in **the detachment area**; avalanche gains speed along the slope (**sliding area**) and stops in the **sticking area** where the snow mass and all the other dragged material (debris, vegetation, etc.) can accumulate.

AVALANCHES

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Detachment area

The **detachment area** is defined as the area where the avalanche originates, and it is influenced by different factors such as site morphology, altitude, sun exposure, vegetation, etc.



AVALANCHES

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Sliding area

The **sliding area** of an avalanche is the terrain where the mass of snow, ice, and debris moves downslope during an avalanche event.

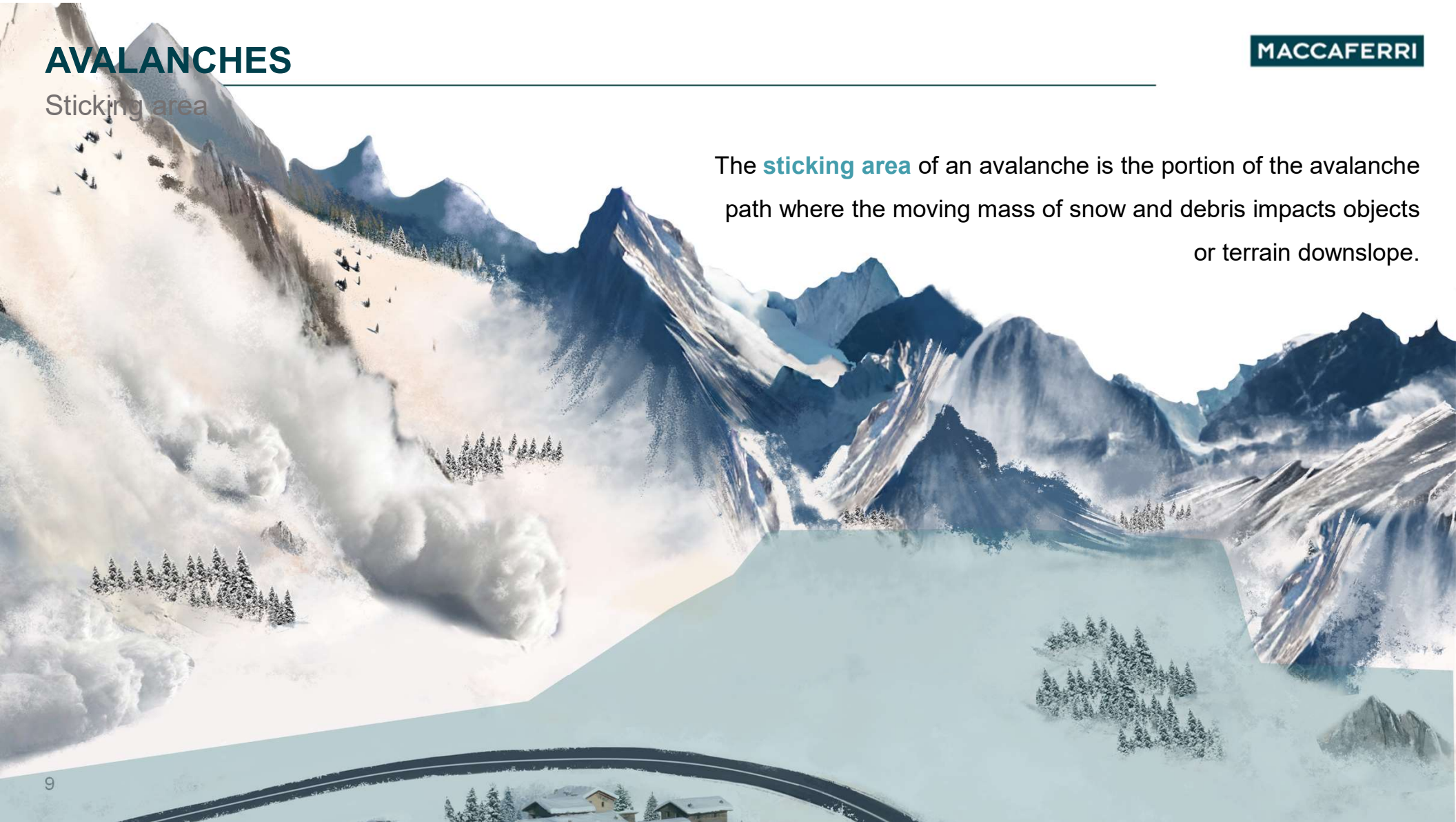


AVALANCHES

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Sticking area

The **sticking area** of an avalanche is the portion of the avalanche path where the moving mass of snow and debris impacts objects or terrain downslope.



The formidable force of avalanches, capable of swiftly moving large quantities of snow and debris, highlights **the vital importance of mitigating their risks**. This imperative is essential not only for **protecting lives** but also for **safeguarding the interests of mountain communities**.

MACCAFERRI EXPERIENCE

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Our experience



With **decades of experience**, Maccaferri has established itself as a **trusted leader** in the field of snow mitigation, providing **proven solutions** that endure the **most challenging** winter conditions.



Mitigation solutions for avalanche risk

MANAGEMENT

Monitoring and controls

before, after and during the snowfall

Artificial Detachment

during and after the snowfall

Interdiction

during and after the snowfall

**Control and reduce
the avalanche RISK**

STRUCTURALS

Active Systems

retaining of snowpack in the detachment area

Passive Systems

deflections, stopping and retaining of snowpack along/at the end of the avalanche path

**Control the
avalanche RISK**



PROTECTION SOLUTIONS

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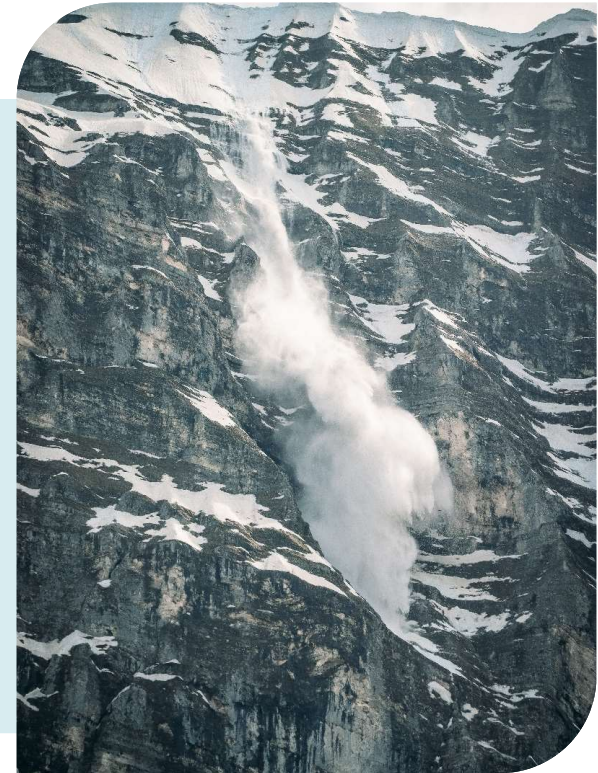
Type of solutions

ACTIVE SYSTEMS

They are aimed to prevent and avoid the initiation of an avalanche, acting on the triggering factors of the event (i.e. snow nets and umbrellas, wind deflectors, snow rakes, etc.) or controlling the movement of the snow.

PASSIVE SYSTEMS

They do not act directly on the instability, but they are aimed to deflect, stop and retain the snow along, or more commonly at the end of, the avalanche path (i.e. concrete structures).



ACTIVE PROTECTION SYSTEMS FOR AVALANCHES

Active systems

Active protection systems are aimed **to avoid the initiation of an avalanche, controlling the movement of the snow and reduce the possibility of avalanche detachment.**

They can be realized with:

- Modification of the soil increasing the roughness of the slope, and then decreasing the possibility of detachment;
- Control of the snow transported by the wind using structures such as wind deflectors;
- Retention of the snow cover with avalanche protection systems such as snow bridges, snow racks, wood or steel structures installed along multiple lines parallel to the detachment area, **snow nets and umbrellas.**



PASSIVE PROTECTION SYSTEMS FOR AVALANCHES

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Passive systems

Passive protection systems are designed **to minimize the impact of avalanches** through strategies that do not actively interfere with snow movement in the detachment area. These solutions often involve the **construction of reinforced embankments or natural barriers, strategically positioned to dissipate avalanche energy/velocity or to stop/deflect the snow flow** and reduce risk.





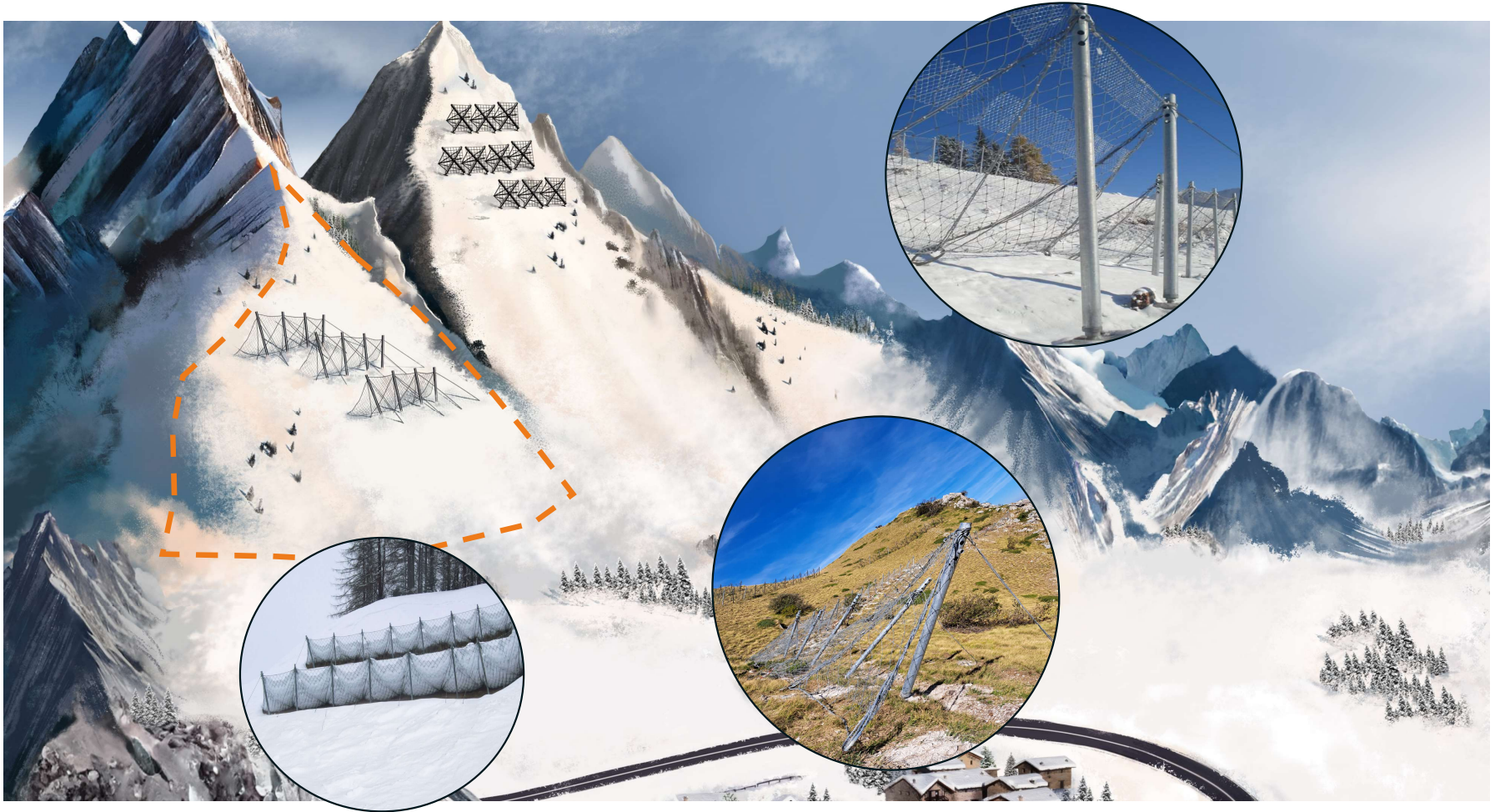
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MACCAFERRI SNOW PORTFOLIO

MACCAFERRI PORTFOLIO AVALANCHE PROTECTION SYSTEMS

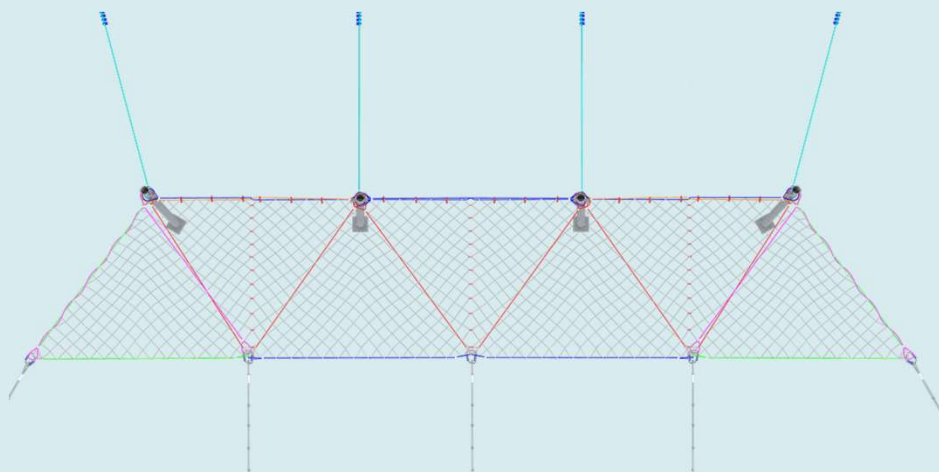
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AvaMac



AVAMAC (ETA)

AvaMac configuration



AVAMAC structures are meant to stabilize the layer of snow in the detachment area, in the same way as Snow Nets, but they are designed according to the new ***EAD 340109-00-0106: Flexible Avalanche Protection Kit***.

They consist of retaining nets, posts, cables and anchors to transmit to the ground the snow loads with different and optimized features compared to the actual Snow Nets.

AVAMAC (ETA)

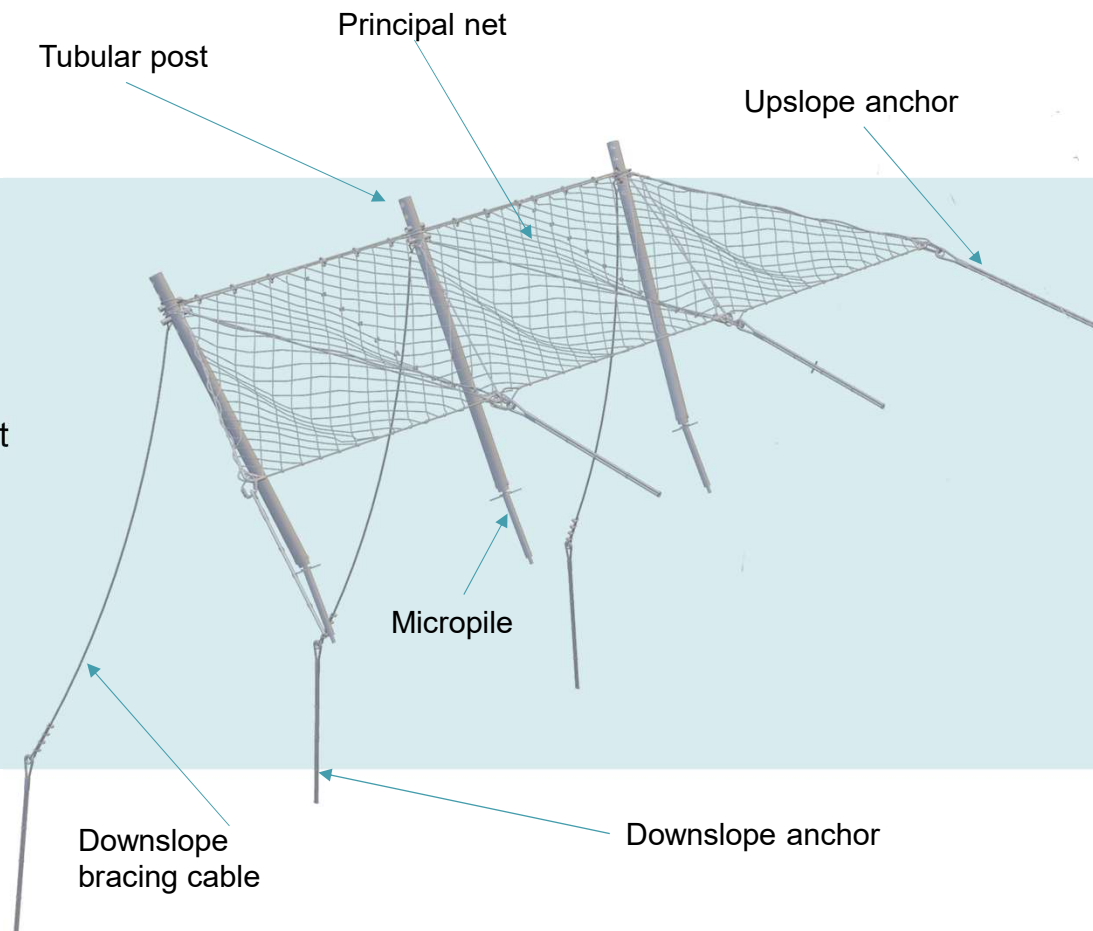
AvaMac configuration

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SNOW NETS COMPONENTS

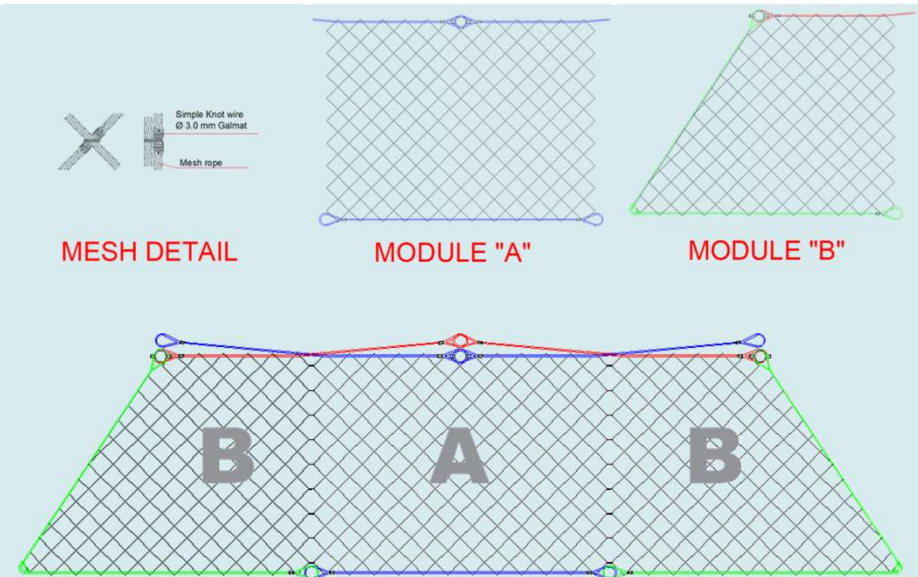
- steel tubular struts
- steel cable panels (**rectangular and trapezoidal shape**)
- steel mesh installed on main cable panels
- upslope and downslope anchors (as well as end point anchors) in order to guarantee the stability of the system.

Effective height of snow net D_k [m]	Glide factor in avalanche starting zone, N	Posts spacing [m]
3.0	2.5 / 3.2	4.0
3.5	2.5 / 3.2	3.5



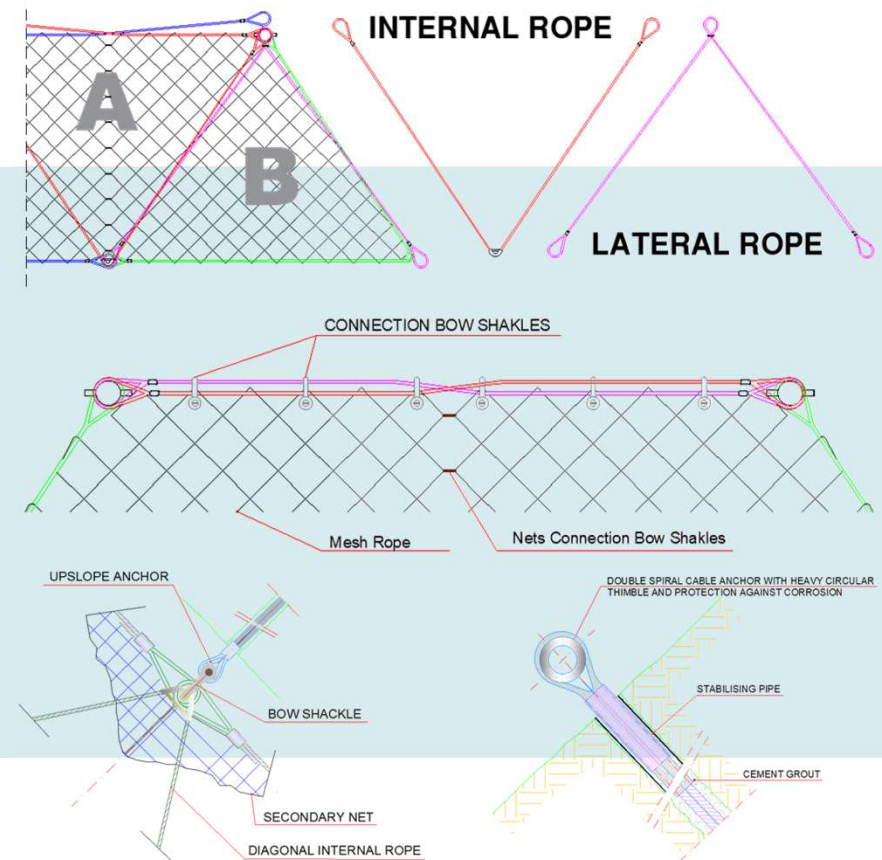
SNOW NETS COMPONENTS

- **RETAINING STRUCTURE:** cable panels made of steel cables. 2 types of **single knot** cable panels:
 1. Rectangular shape for intermediate panels (Module A);
 2. Trapezoidal shape for intermediate panels (Module B);
- **SUPPORT STRUCTURE:** steel tubular posts fixed to the ground at the base by means of a universal spherical joint and at the top by means of cable panels and downslope bracing cables.



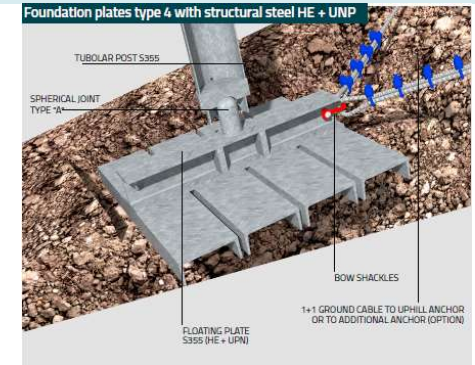
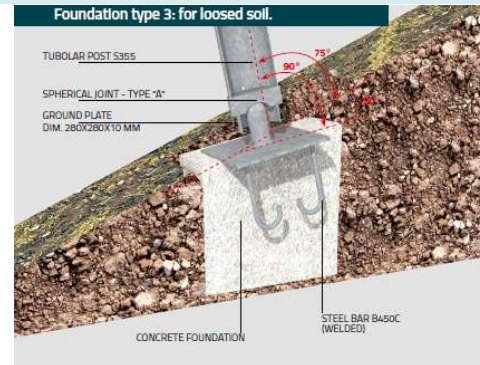
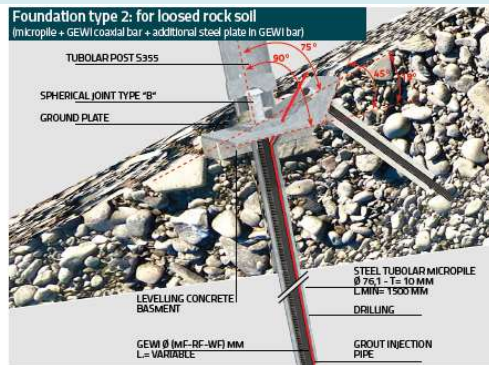
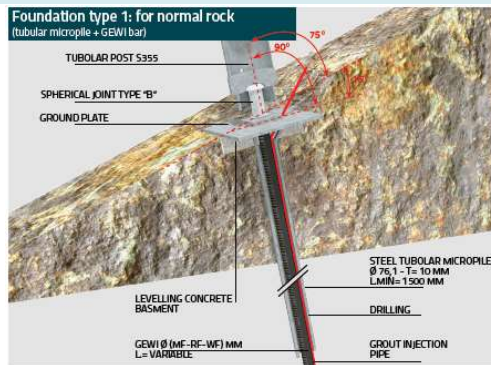
SNOW NETS COMPONENTS

- **CONNECTION ELEMENTS:** shackles/cable windings/slings are used for connecting the reinforcing steel ropes with the anchors system and posts foundations, and then transferring the loads acting on the retaining structure directly to the ground.
- **ANCHORS SYSTEM AND POSTS FOUNDATIONS:** these components transfer the loads acting on the structure to the ground. The anchors system consists of upslope and downslope flexible anchors (double spiral cables); the posts foundations instead can be realized with **four** different typologies (depending on the type of ground).



FOUR TYPE OF FOUNDATIONS FOR ALLOWING THE INSTALLATION ON EVERY TYPE OF GROUND CONDITIONS AND CUSTOMER PREFERENCES.

- **Type 1** (for normal rock): Tubular micropile + GEWI bar
- **Type 2** (for loosed rock soil): Tubular micropile + GEWI coaxial bar + shaped steel plate with supplementary GEWI bar
- **Type 3** (for loosed soil): Concrete plinth
- **Type 4** (for bad quality soil and permafrost): Floating plate made of HE+UNP steel profiles + additional flexible anchor



AVAMAC (ETA)

Main features

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The AVAMAC solution, designed as an active snow nets system against avalanches, boasts a **CE mark** for the **EAD 340109-00-0106: Flexible Avalanche Protection Kit**. This recognition by the European Union sets **AVAMAC** as a **standard of quality**.

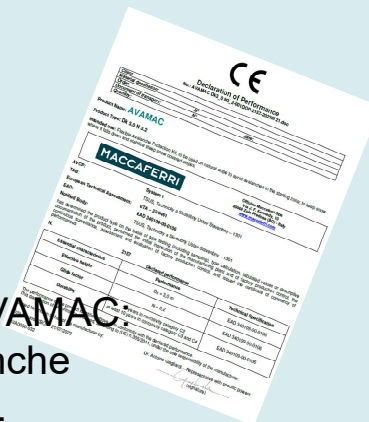


EAD

EAD 340109-00-0106: Flexible
Avalanche Protection Kit.

CE

CE mark on AVAMAC:
Flexible Avalanche
Protection Kits.



AVAMAC (ETA)

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AVAMAC goes **beyond functional excellence** to provide an active solution against snow avalanches with an **added aesthetic appeal**, making it **well-suited even for natural parks**. The **seamless integration of design and robustness** makes AVAMAC an ideal choice that **effortlessly blends into natural surroundings**, ensuring both structural integrity and visual aesthetics.



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The AVAMAC structure's **innovative design** excels in supporting heavy snow loads. Its **flexible, continuous** framework, coupled **with both downstream and upstream anchoring**, ensures **resilience and adaptability**. The system is optimized for **quick installation** and continuous improvement, making it a **robust and efficient solution**.

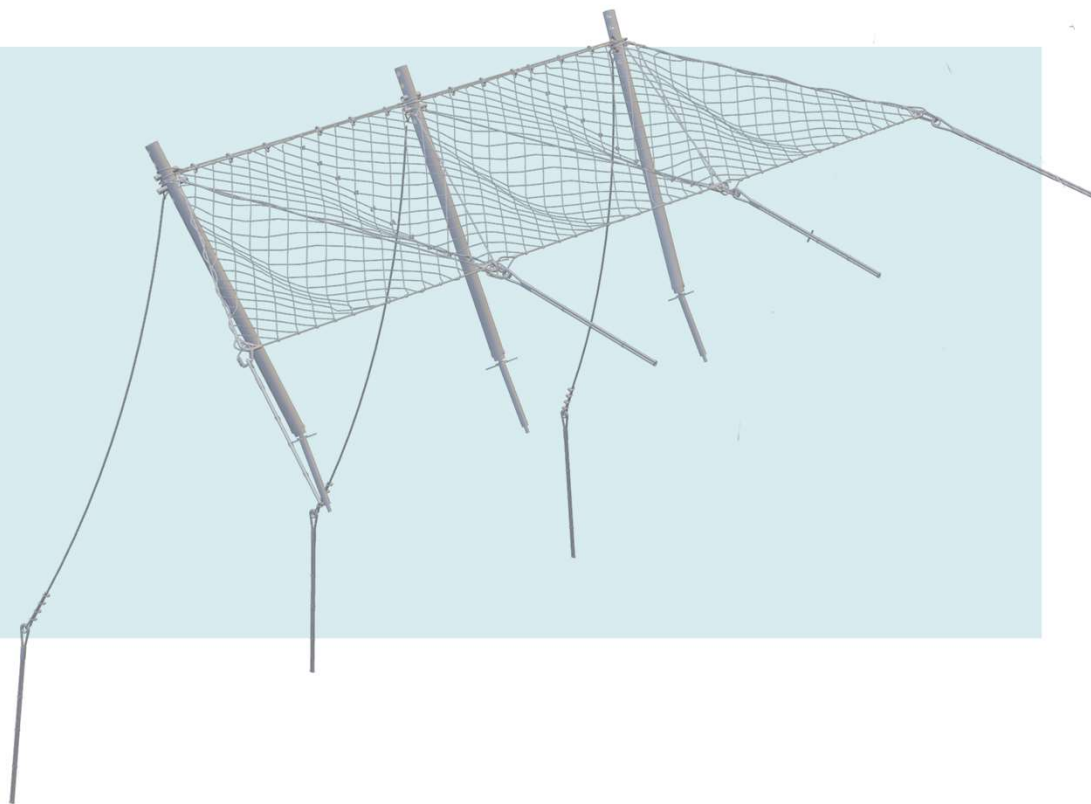


AVAMAC (ETA)

AvaMac portfolio

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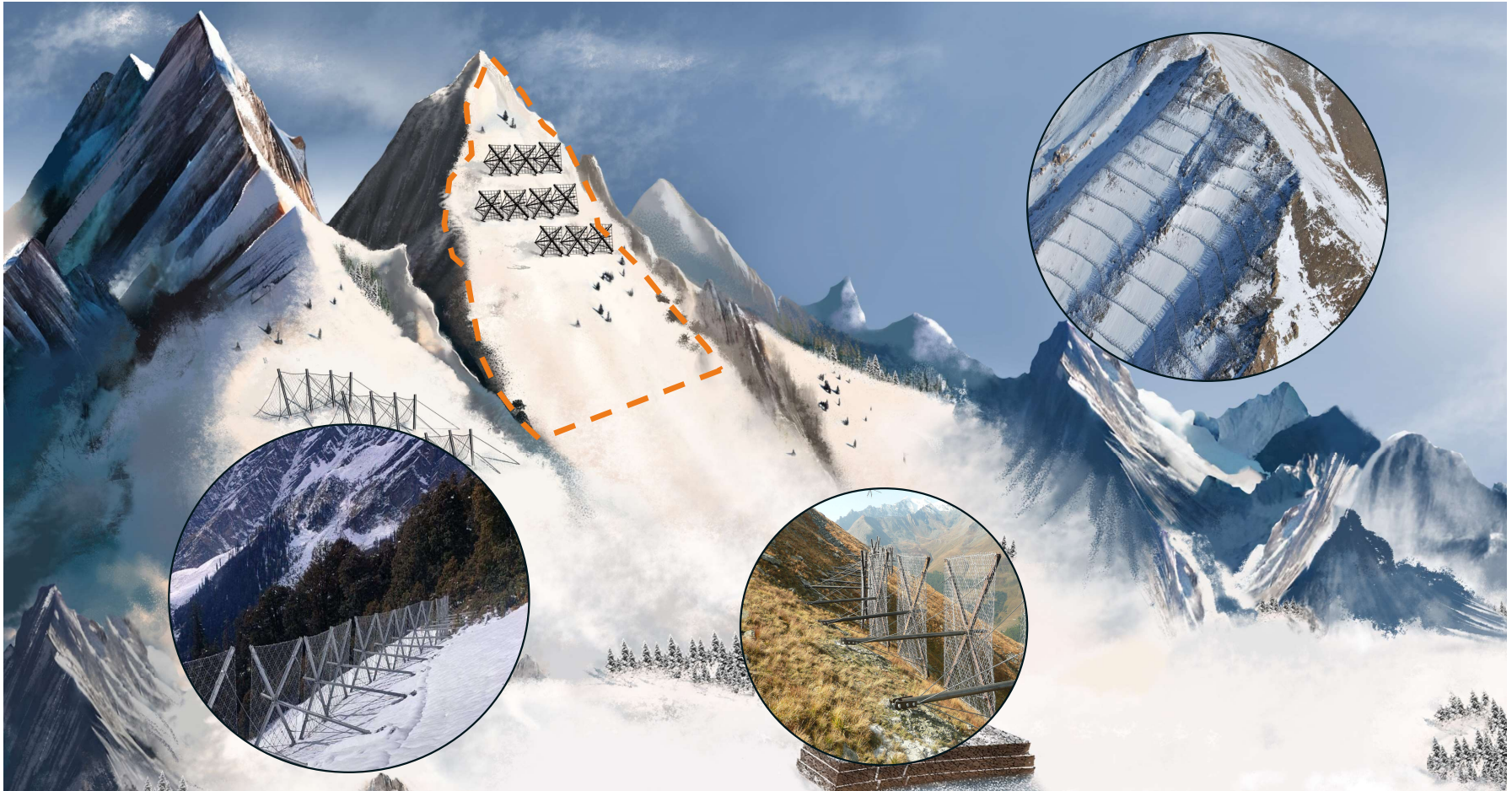
Effective height of snow net Dk [m]	Glide factor in avalanche starting zone, N	Struts spacing [m]	ETA	S_{NK} [kN/m]
3.0	2.5	4.0	22/0039	44.3
3.0	3.2	4.0	22/0461	56.7
3.5	2.5	3.5	21/0966	60.3
3.5	3.2	3.5	23/0150	77.2



MACCAFERRI PORTFOLIO AVALANCHE PROTECTION SYSTEMS

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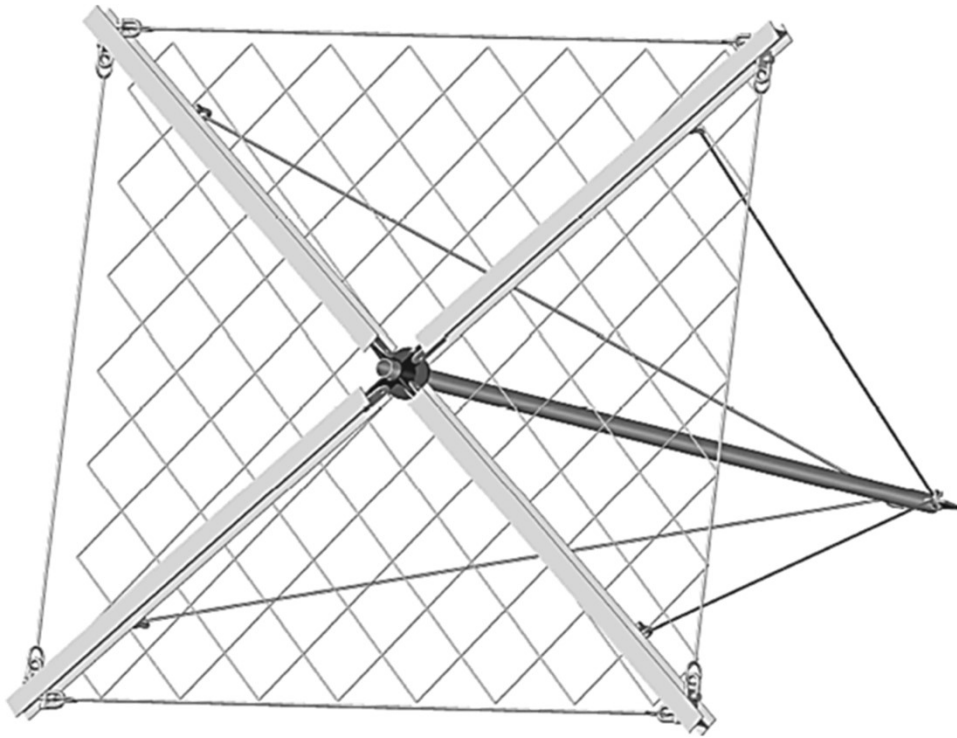
ReadyMac



READYMAC

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ReadyMac - Definition

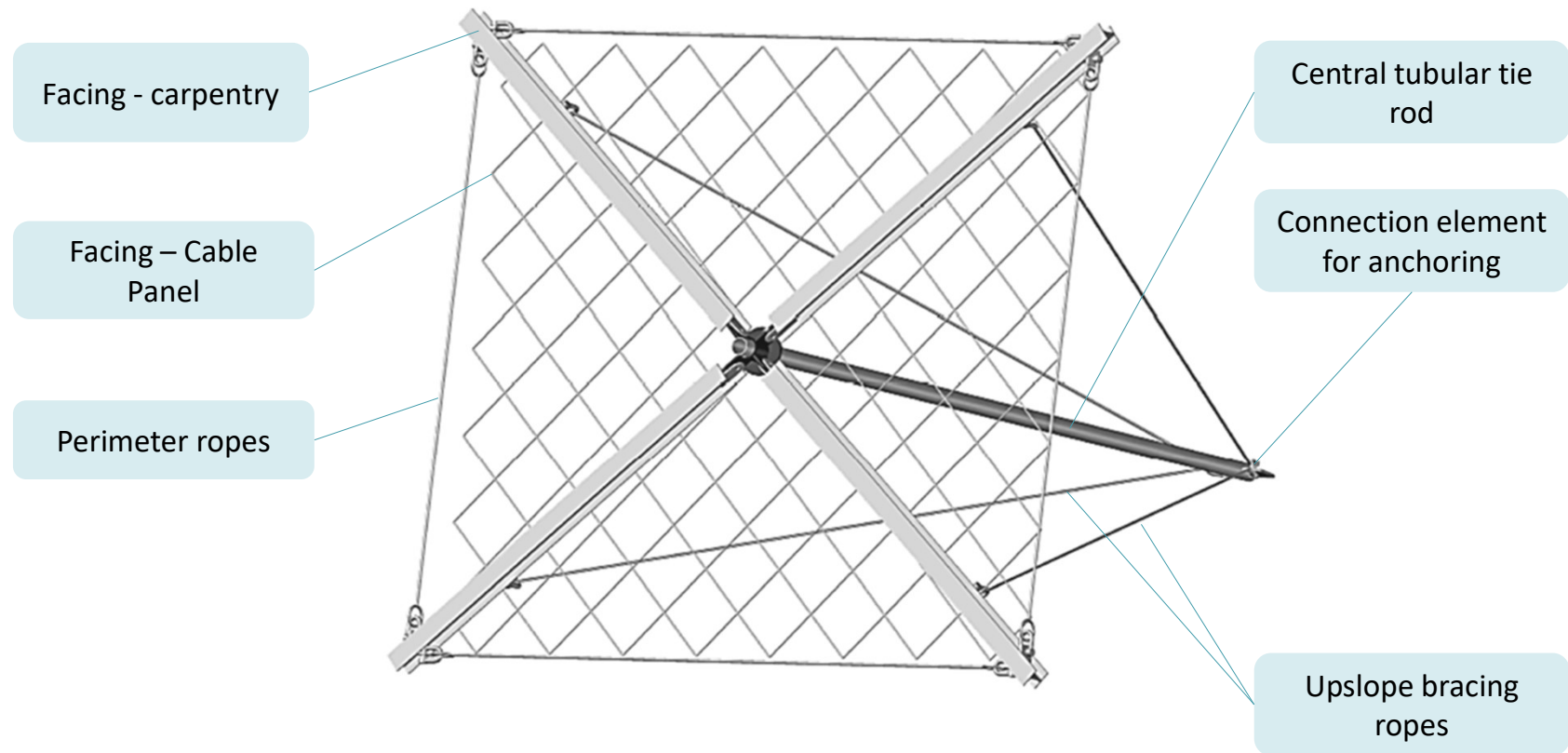


The mono-anchored umbrella systems are **single-element structures**, anchored to the ground by means of a **deep flexible anchor**, and aimed at **stabilizing the snowpack** in areas of possible avalanche detachment areas. These technologies allow the mitigation of the avalanche risk in the detachment area according to the most recent regulations and scientific research in the sector.

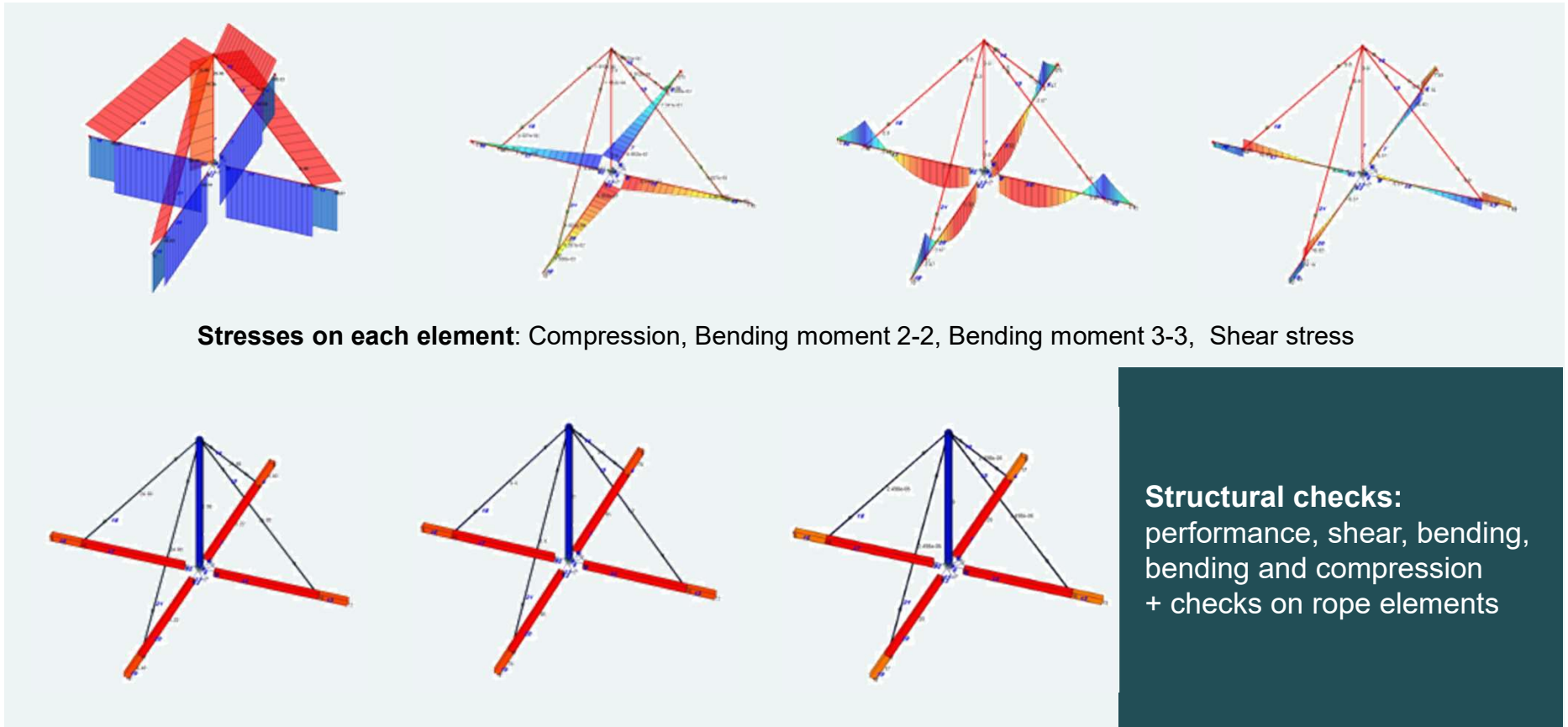


Designed according to Swiss guidelines (DAVOS)

ReadyMac - Components



Every structure is structurally analyzed and checked using finite elements modeling



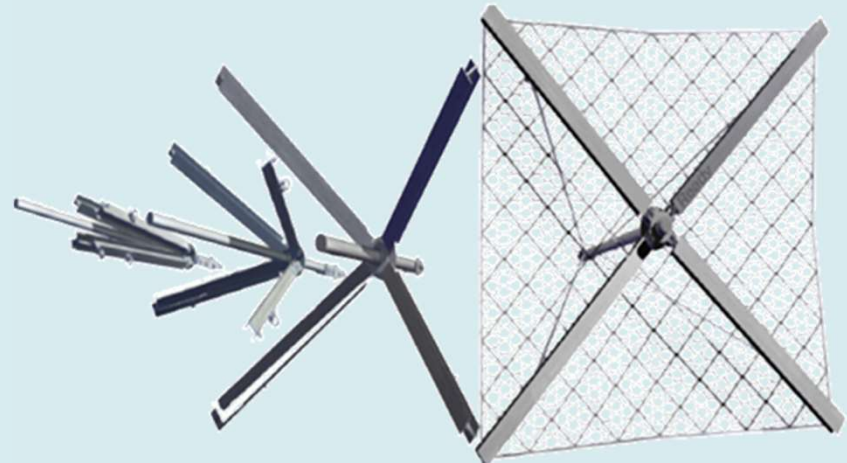
READYMAC

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Main features



The use of fully **pre-assembled ReadyMac structures simplifies installation and transport operations**. These structures are aligned along contour lines, positioned directly on leveled and arranged ground. Due to their low weight, ReadyMac systems are **suitable for installation in challenging and hard-to-access conditions**, making them adaptable to transportation via helicopters.



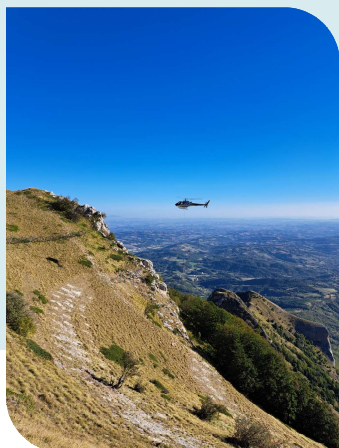
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Umbrella snow structures are generally installed and aligned along the contour lines; the structures are positioned **directly on the ground**, previously leveled and properly arranged. Considering the **low weight**, these systems are suitable for being installed even in **very impervious and difficult to access conditions** using helicopters for transportation.



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MACCAFERRI

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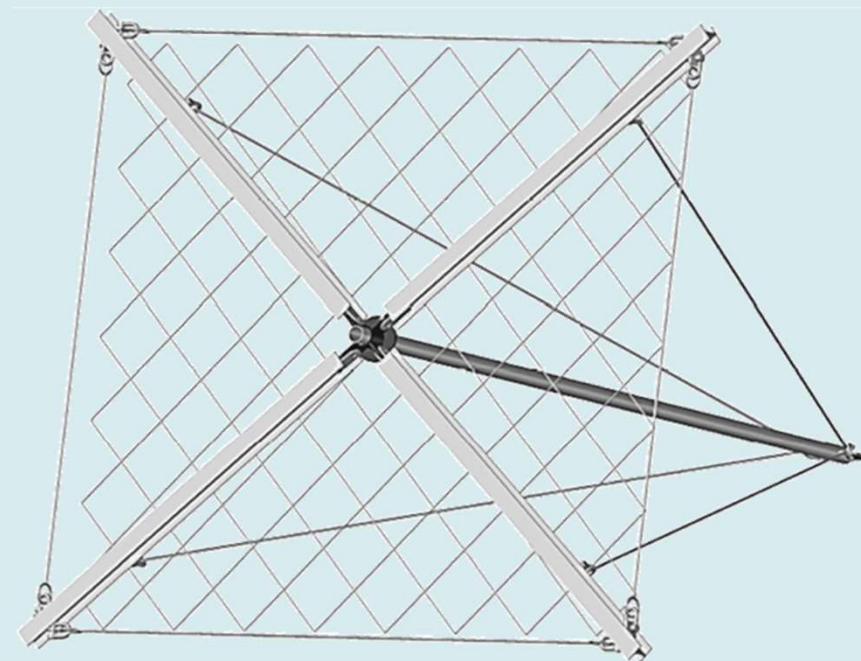
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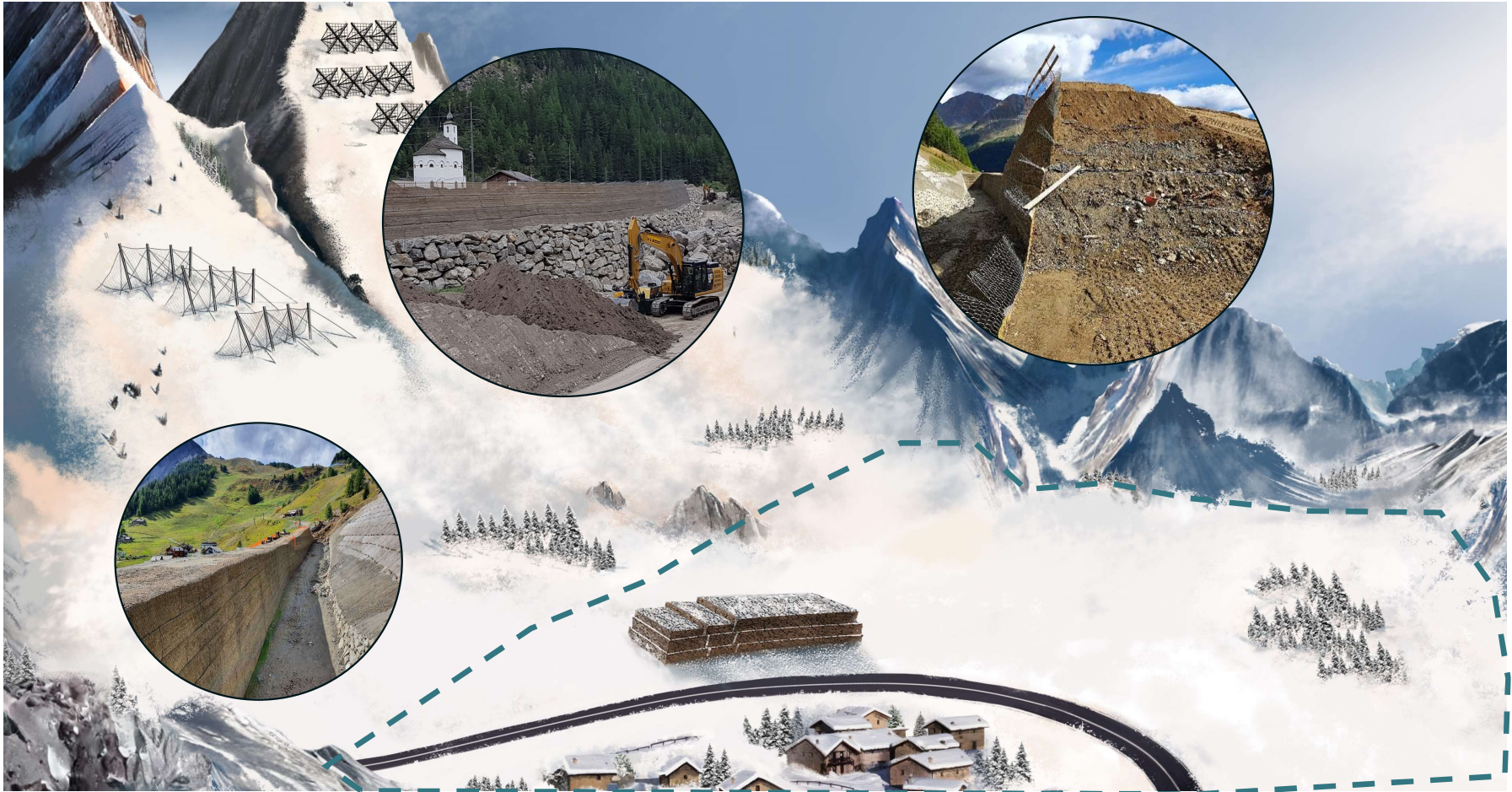


ReadyMac structures, with their **single-anchor design**, guarantee **straightforward installation** even in extreme conditions, **emphasizing simplicity** and **heightened safety**. Despite their lightweight nature, these structures remain **efficient** and **high-performing**, contributing to cost reduction and making them an economical choice.



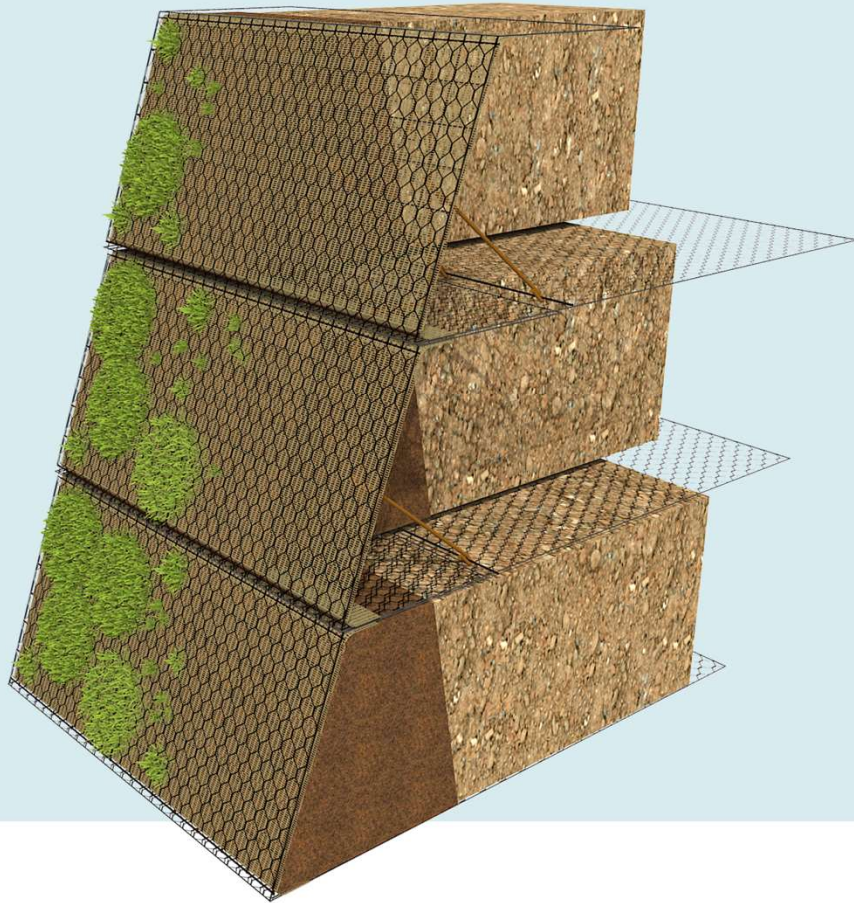
Dk (Snow thickness in the detachment area)	Glide factor in avalanche starting zone, N
3,0	2,5- 3,2
3,5	
4,0	



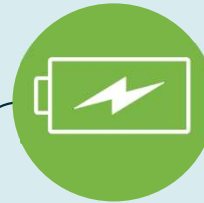


TERRAMESH GREEN

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TerraMesh Green is an environmentally friendly modular system used to form green-faced soil reinforced slopes and embankments.



120
YEARS
DESIGN
LIFE



150 m²
INSTALLED
IN A SHIFT



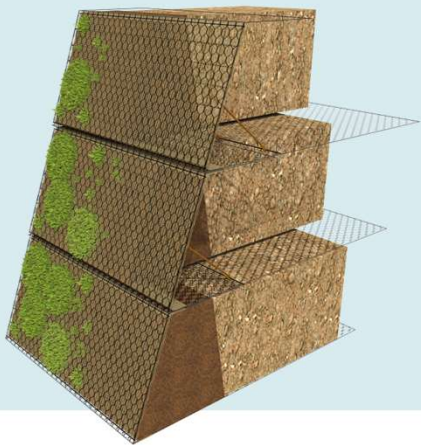
ENHANCED
ECOSYSTEM
DIVERSITY AND
CARBON
SEQUESTRATION

EMBANKMENTS

Why is TerraMesh the best?



TerraMesh solutions, with their integrated double twisted steel wire mesh and DT soil reinforcement, offer a **seamless and connection-free structure**, making them ideal for applications such as avalanche protection. Their **high panel resistance** and **distributed load capacity** make them particularly well-suited for effectively mitigating the impact of avalanches.



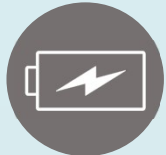
EMBANKMENTS

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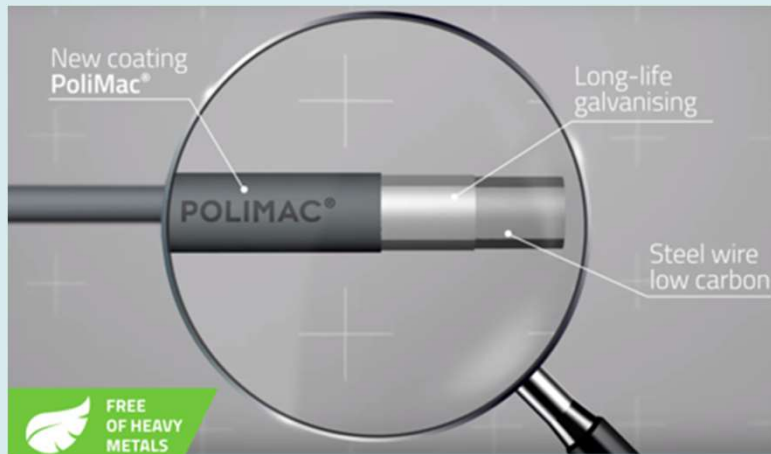
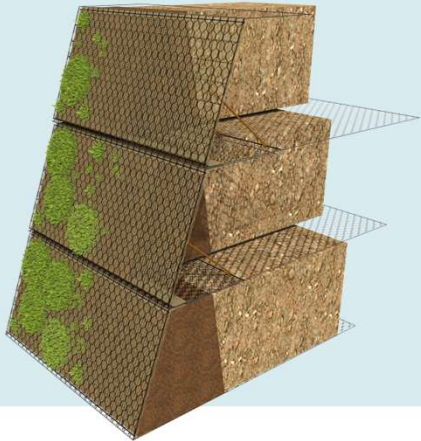
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All TerraMesh solutions are constructed with **PoliMac coated wire mesh**, a revolutionary coating known for significantly enhancing durability, especially in harsh climatic conditions. Notably, PoliMac excels in low-temperature environments, making TerraMesh an optimal choice for projects in extremely challenging and cold climates.



PoliMac®
WIRE PROTECTION FOR A CHANGING WORLD

12x

Better resistance to **abrasion**, including installation damages

2x

More resistance to **chemical aggressions***

-35°

More performance in cold weather

2x

More resistance to **UV rays****

EMBANKMENTS

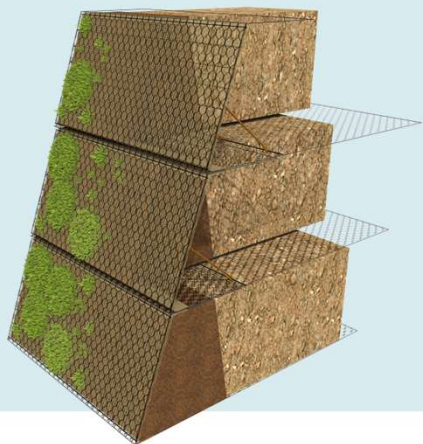
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EMBANKMENTS

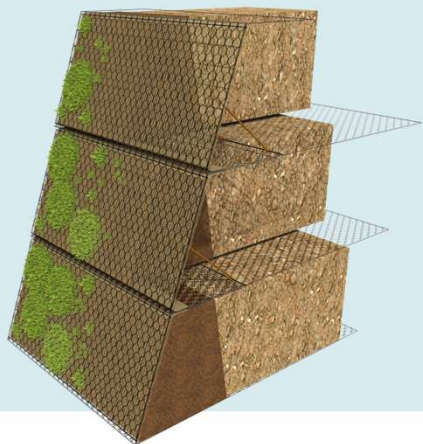
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TerraMesh not only excels in functionality but also offers **aesthetic appeal**, making it a **fitting choice even for natural parks**. The harmonious integration of design and durability makes TerraMesh an **ideal solution that blends seamlessly** with natural environments, ensuring both structural integrity and visual aesthetics.

Why choosing a TerraMesh solution?

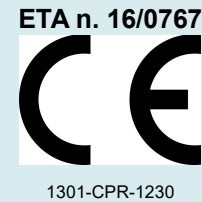
Our design process is focused on test campaigns and investments in performance evaluation of our solutions.



Approval on the product quality including testing in laboratories, onsite evaluations, quality management checks and inspections of production



Transparent and comparable information about the life-cycle environmental impact of products



Continuous control of product performance in compliance with EU legislation



Highway Innovative Technology Evaluation Center – an evaluation performed by a panel of experts - final report is the result of an impartial, consensus-based approach to evaluating the system



Rigorous certification procedure to ensure that the performances of commercial kits conform to predefined performances criteria



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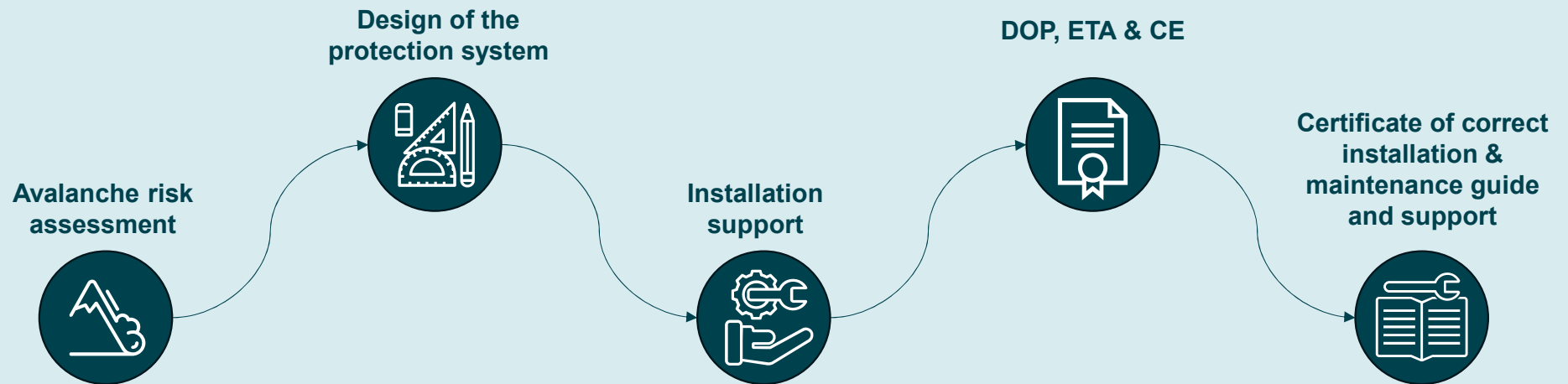
MACCAFERRI TECHNICAL SUPPORT

TECHNICAL SUPPORT

MACCAFERRI

Specialized support for all the project phases

Working with Maccaferri means having a specialized support for all the project phases :



TECHNICAL SUPPORT

MACCAFERRI

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Avalanche risk assessment



TOPOGRAPHICAL DATA

DTM – digital terrain model of the area under analysis (note: the DTM must be extended to the overall avalanche path – release, flowing and run-out zones)

Aerial photographs of the area under analysis

METEOROLOGICAL DATA

Daily data of Hs (total snow cover height) from a representative snow station (relatively long series are needed in order to perform proper statistical analysis and accurate design of AVAMAC and avalanche modelling)

Wind data and temperature data from a representative weather-station

AVALANCHE DATA

Information about **known avalanche event** (if possible starting area and maximum outline of known avalanche events drawn on a map).

GEOTECHNICAL DATA

Stratigraphy of the area where AVAMAC must be built (e.g. thickness of loose terrain if present, depth of rock, ecc.)

Geotechnical characterisation of the strata

TECHNICAL SUPPORT

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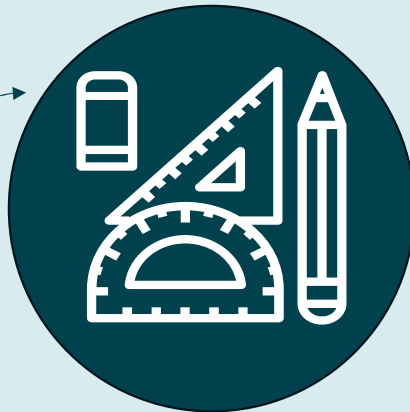
Specialized support for all the project phases

Working with Maccaferri means having a specialized support for all the project phases :

Avalanche risk
assessment



Design of the
protection system



Embankments



ReadyMac



AvaMac

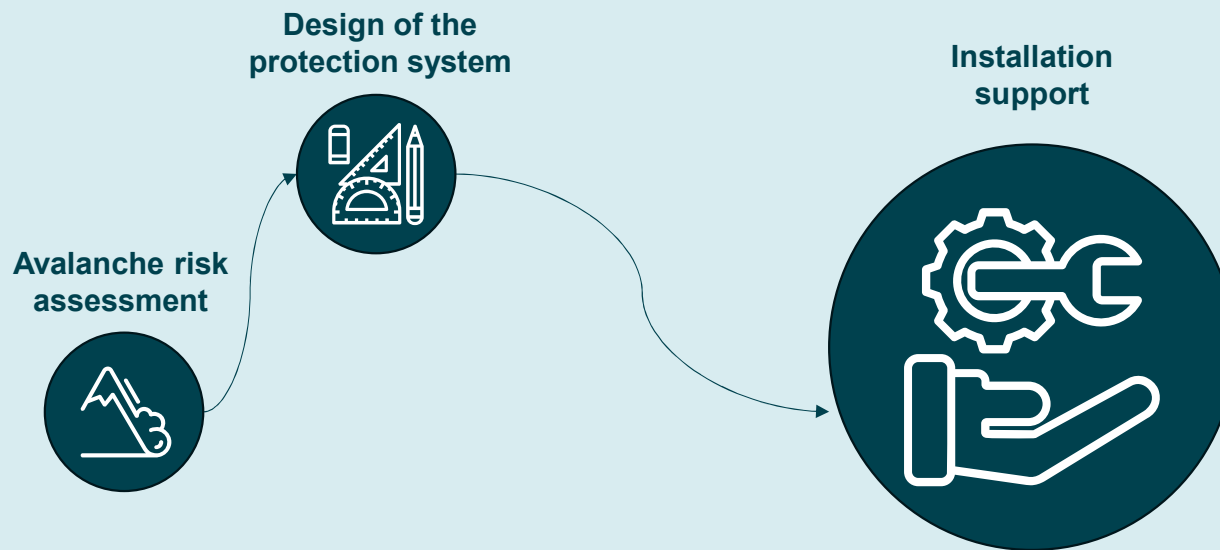


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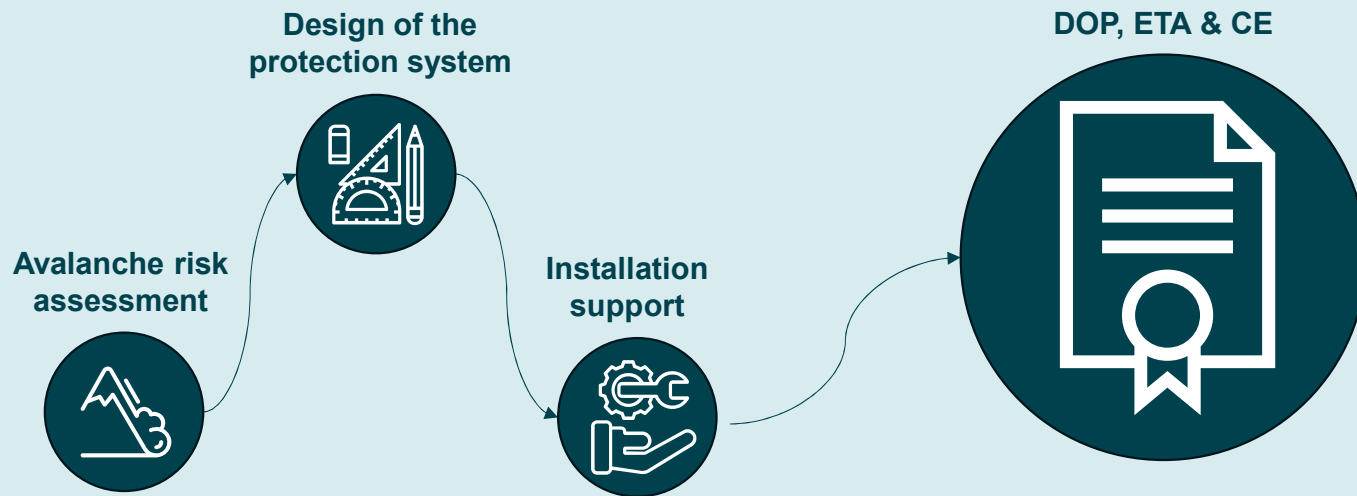


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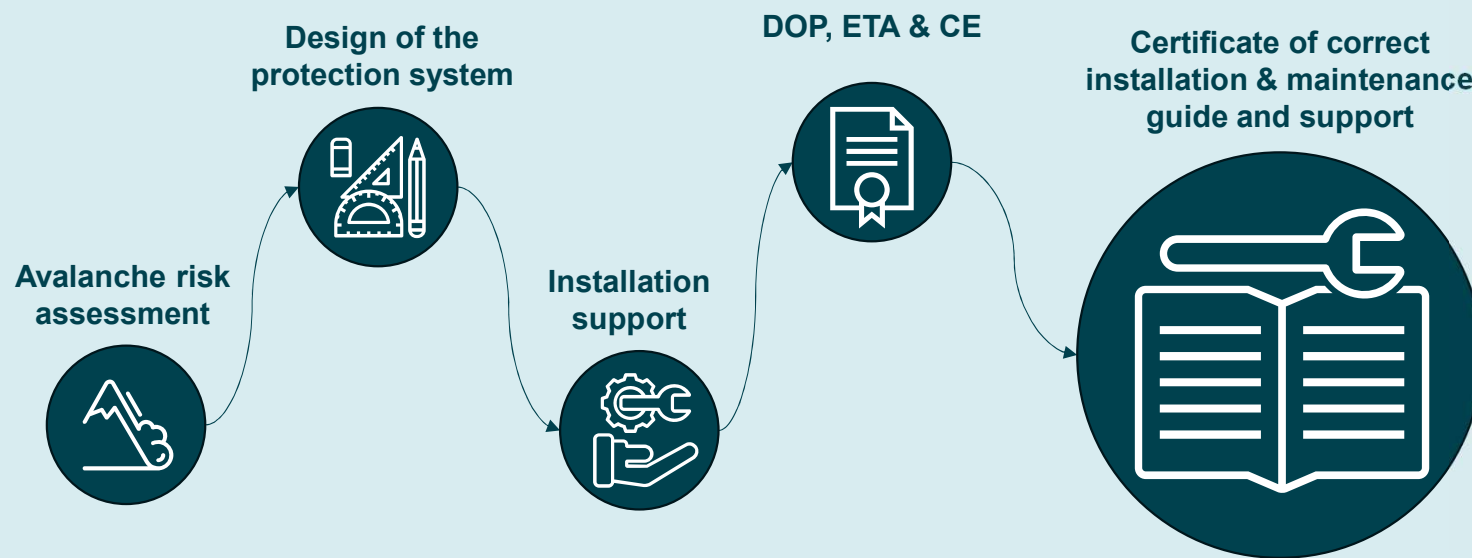


TECHNICAL SUPPORT

Specialized support for all the project phases

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TECHNICAL SUPPORT

360° Support for your project

MACCAFERRI

Do you need technical assistance?

Our engineers are always here to support you in designing and selecting the most suitable solutions for every type of project. Type “**technical assistance**” in the chatbox or visit our website at www.maccaferri.com.



Chat box

MONITORING

MONITORING

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Maccaferri leading the Industry in Smart Solutions



Maccaferri is dedicated to **enhancing safety** through the **strategic integration of smart solutions**, leveraging **cutting-edge technology** to set new benchmarks in geotechnical engineering.

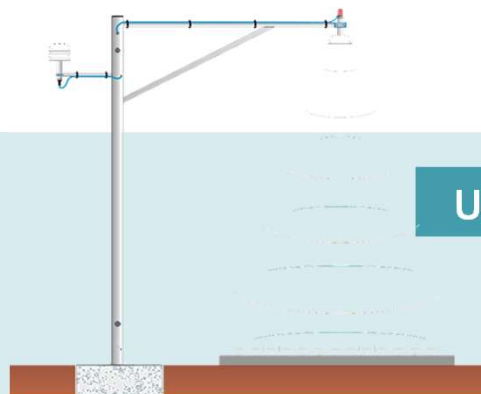
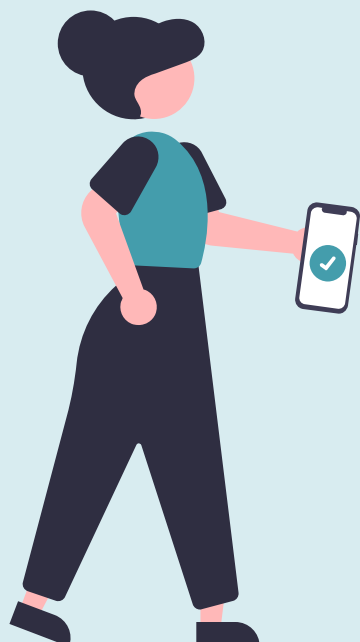


**SERVICEABILITY UNDER
CONTROL**

MONITORING

Smart Snow Monitoring Solutions

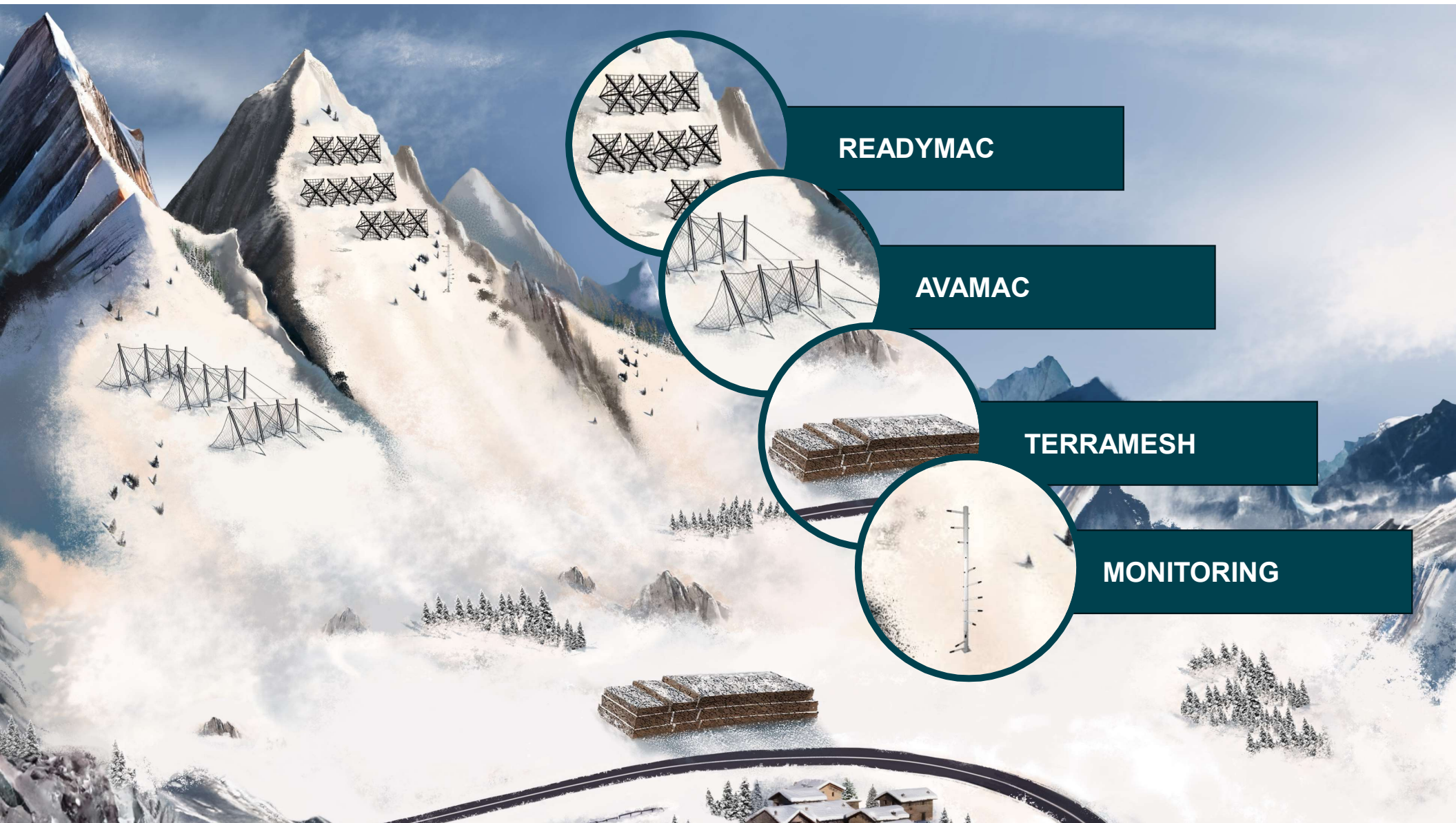
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ULTRASONIC LEVEL SENSOR

SNOW TEMPERATURE PROFILER





READYMAC

AVAMAC

TERRAMESH

MONITORING



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LIVE Q&A