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Engineering a Better Solution

Maccaferri's motto is 'Engineering a Better Solution'; We don't merely supply products, but work in partnership with our clients, offering technical expertise to deliver versatile, cost effective and environmentally sound solutions. We aim to build mutually beneficial relationships through the quality of our service and solutions.

GLOBAL ENGINEERS

In the second half of the 19th century we invented Gabions and dramatically changed civil engineering landscape. We are still changing today. We work every day to find better solutions for our clients at every degree of latitude and longitude. Our worldwide network grows through innovation and diversification of sectors of activity and through an increasing range of high quality and environmentally friendly products and applications.

OFFICINE MACCAFERRI GROUP PROFILE

Founded in 1879, our Group soon became a worldwide reference in the design and development of advanced solutions, with offices in over 70 countries and 30 factories worldwide.

Our mission is to pursue excellence through continuous improvement, while delivering to customers engineered solutions that are innovative, advanced and environmentally friendly. We are committed to outstanding safety, quality and sustainability, to create value for all stakeholders as well as our communities.

MACCAFERRI APPLICATIONS

 RETAINING WALLS
& SOIL REINFORCEMENT

 HYDRAULIC WORKS

 ROCKFALL PROTECTION
& SNOW BARRIERS

 EROSION CONTROL

 SOIL STABILISATION
& PAVEMENTS

 BASAL REINFORCEMENT

 COASTAL PROTECTION,
MARINE STRUCTURES & PIPELINE
PROTECTION

 ENVIRONMENT, DEWATERING
& LANDFILLS

 DRAINAGE OF STRUCTURES

 TUNNELLING*

 LANDSCAPE & ARCHITECTURE

 SAFETY & NOISE BARRIERS

 FENCING & WIRE

 AQUACULTURE NETS/CAGES

 CONCRETE FLOORING,
PRECAST & OTHER USES*

 INDUSTRIAL
MANUFACTURING

MACCAFERRI





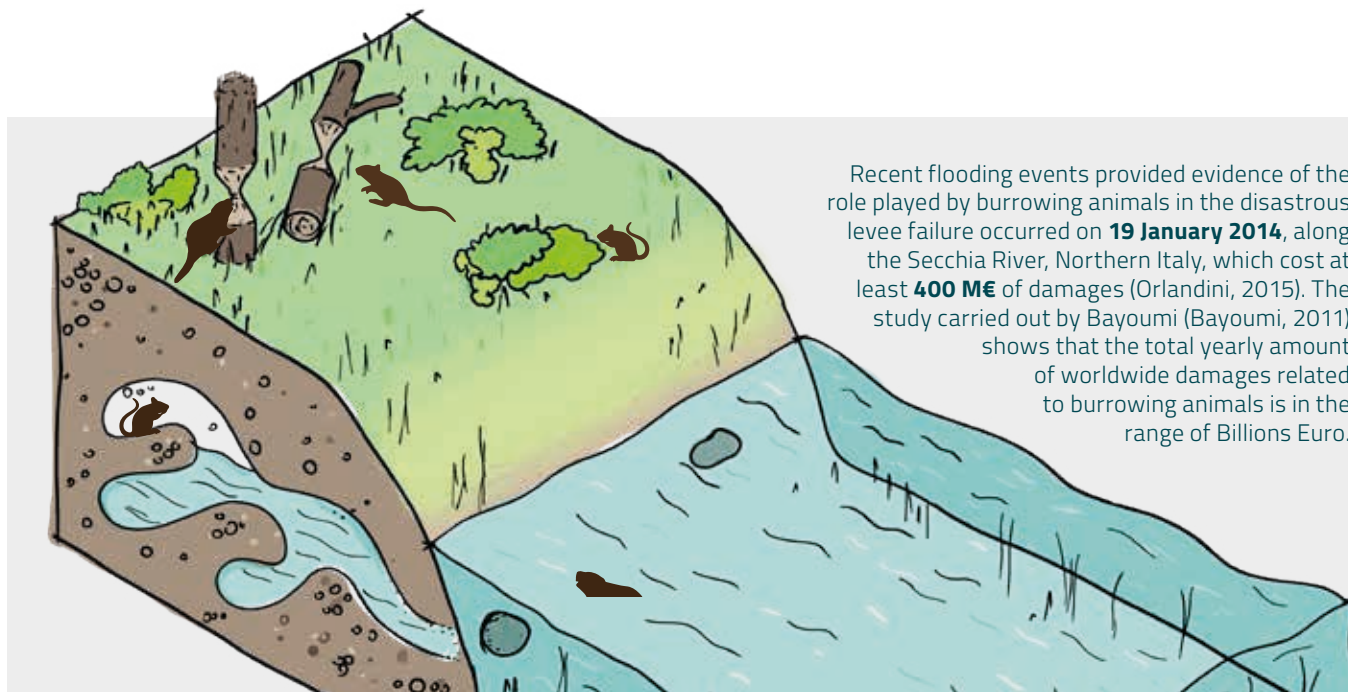
ANIMAL FRIENDLY ANTI-BURROWING SOLUTIONS

THE EFFECTS OF BURROWING ANIMALS

Beavers, badgers and other burrowing animals can sometimes cause fairly large damage on bank slopes, along dykes or in the earth-filled embankments.

In isolated cases, such damage caused by these mammals could lead to an increased risk of global slope failures with serious consequences of over flooding for the communities living in the area. Cavities created by beavers can be of high risk for the stability of the dyke.

The population of burrowing animals has been significantly growing over the past few decades, particularly in Central Europe and North America.



Recent flooding events provided evidence of the role played by burrowing animals in the disastrous levee failure occurred on **19 January 2014**, along the Secchia River, Northern Italy, which cost at least **400 M€** of damages (Orlandini, 2015). The study carried out by Bayoumi (Bayoumi, 2011) shows that the total yearly amount of worldwide damages related to burrowing animals is in the range of Billions Euro.

Burrowing animals' lodges, especially beavers' ones, have an underwater entrance. This keeps those animals safe from predators but poses a threat to the river bank stability.





Other burrowing animals such as badgers dig lairs with multiple entry points. If those extensive tunnels are dug under road/railway embankment, those leave a high risk of subsidence to the bank and road/rail track.



THE BEHAVIOUR OF BURROWING ANIMALS

In early 2000', the Italian Ministry of the Environment, in coordination with the "National Institute for the Wild Fauna" and the "Institute for the Protection and Environmental Research (ISPRA)" (Cocchi & Riga, 2005) promoted a long term study on beavers behaviour. The study was based on the continuous monitoring of the animals through smart devices in order to understand their habits.

There is evidence of positive experiences to permanently safeguard the banks using polymer coated steel wire mesh and composite without harming the animals.

The steel mesh works as an effective long-term barrier against the intrusion of beavers, badgers and other burrowing animals, discouraging them from digging inside the levee core.

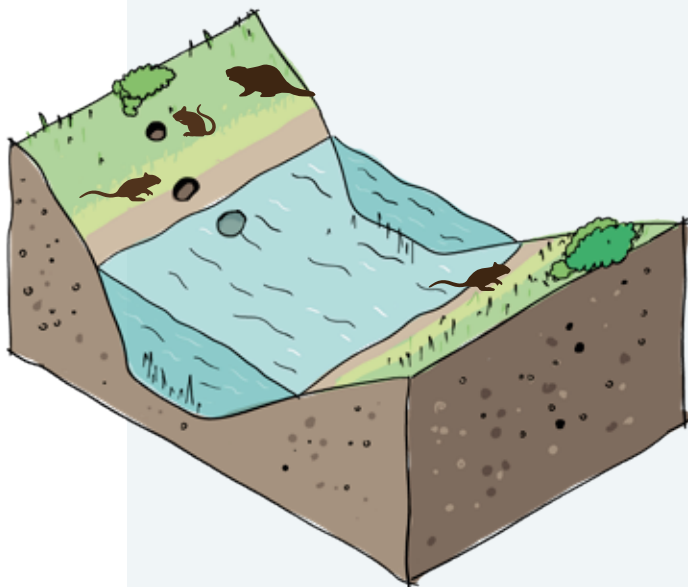
The study proved that if burrowers are discouraged from digging into the embankment they migrate to other areas.

The correct approach consists in identifying non-critical areas where beavers could dig their tunnels without altering the embankment's stability while protecting the most critical areas.



"We deliver solutions that integrates into the environment, in a way that considers wildlife already living around it."

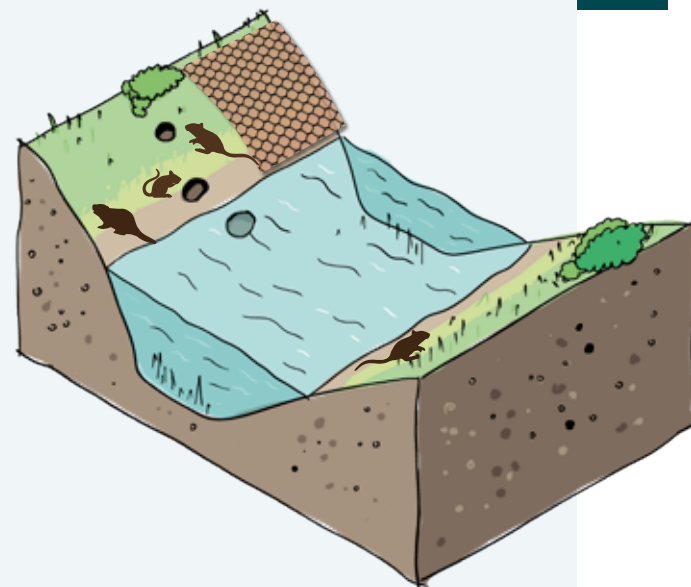




1

UNPROTECTED STRETCH

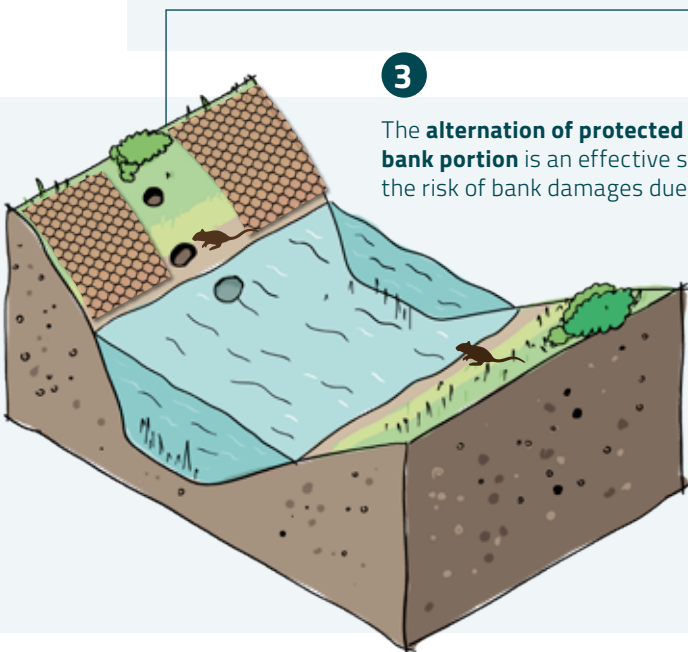
Beavers, badgers and other burrowing animals are free to burrow the river bank or the earth filled embankment.



2

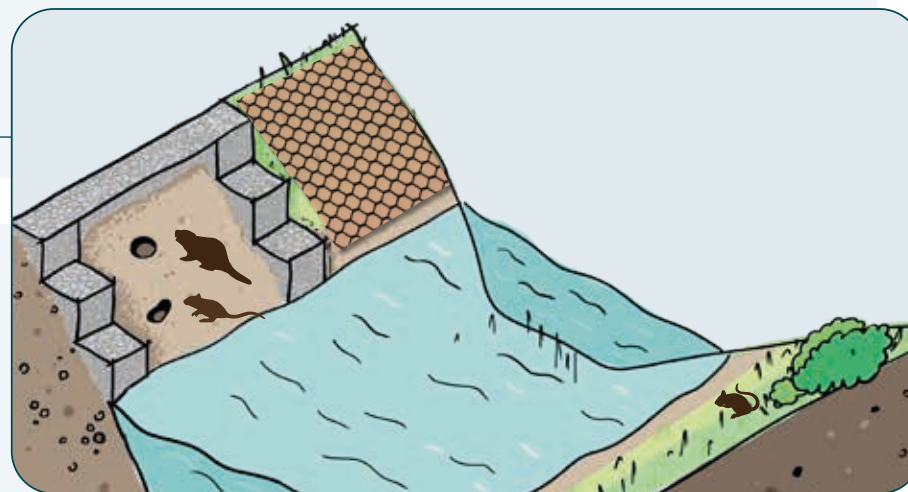
BEAVERS RELOCATION

The use of polymer coated wire mesh in critical areas induces burrowing animals to move **away from the protected stretch**. The animals relocate to an area where they can dig their lodges.



3

The **alternation of protected and unprotected bank portion** is an effective solution in managing the risk of bank damages due to beaver burrowing.



AN AESTHETICALLY PLEASING AND ANIMAL FRIENDLY SOLUTION

Environmentally friendly solutions such as **Gabion walls** can be used to create dedicated areas where beavers, badgers and other burrowing animals can dig their lodges without affecting the stability of the river bank.

OUR SOLUTION

RENOMESH Series is the range of certified and long lasting protection to discourage burrowing animals from digging. **RENOMESH** is made of environmentally friendly double twist wire meshes, it is easy to install and durable also in aggressive environmental conditions.

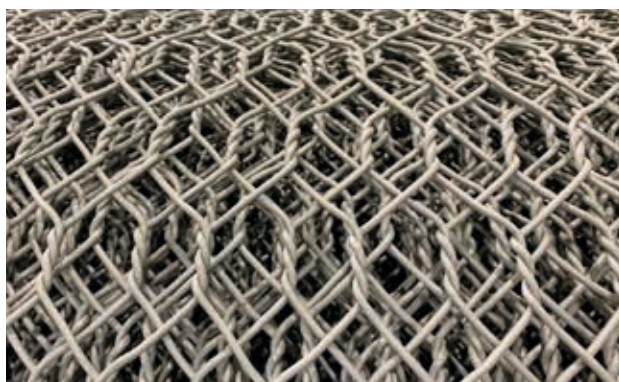
RENOMESH prevents burrowing animals intrusion in dykes and embankments thus preventing damages on bank slopes and earth-filled embankments.

RENOMESH BIO and **RENOMESH GREEN** are 2-in-1 solution that combines the strength of the steel wire mesh with the ability to promote vegetation.

RENOMESH BIO is made by a three dimensional biomat made of natural fibers. The strenght of the steel mesh will act as an impenetrable barrier for the rodents who will not be able to dig a hole through the steel net. The biomat will combine the antierosion function: by holding moisture will promote vegetation

during the low flow season. The use of anti-burrowing solutions with integrated biomat allows a rapid establishment of the vegetation.

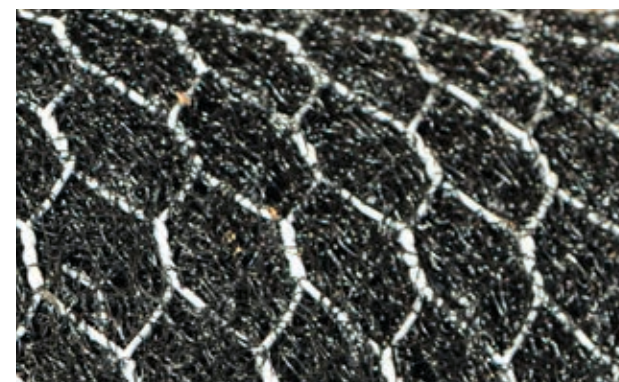
RENOMESH GREEN combines steelwire mesh with 3D synthetic geomat for long lasting performance. **RENOMESH GREEN** is ultimate for extra soil retention effect, increasing top soil deposit upon the geomat and consequently the slope revegetation.



RENOMESH



RENOMESH BIO



RENOMESH GREEN



RENOMESH, RENOMESH BIO and RENOMESH GREEN are made from recycled steel wire rod in compliance with international standards. **RENOMESH BIO** additionally features a 100% biodegradable coconut fibers.

RENOMESH, RENOMESH BIO and RENOMESH GREEN are available with a protective long-lasting PoliMac® polymer coating.

SOLUTION	FUNCTIONS	TECHNICAL CHARACTERISTICS
RENOMESH	ANTI-BURROWING FUNCTION	6x8 mesh type is suited to prevent the intrusion of young rodents or small species such as ground squirrels or Crayfish species (e.g. American Crayfish <i>Procambrus Clarkii</i>) and, consequently the intrusion of medium/big size rodents such as beavers, muskrats, badgers.
RENOMESH BIO	ANTI-BURROWING + EROSION CONTROL FUNCTIONS	6x8 mesh type featuring biodegradable fibres properly integrated to DT Mesh during manufacturing.
RENOMESH GREEN	ANTI-BURROWING + LONG TERM EROSION CONTROL FUNCTIONS	6x8 mesh type featuring a geomat made from a three-dimensional matrix of UV stabilized, non-degradable synthetic fibres, heat bonded where they cross, extruded onto a polymer coated double twisted steel woven mesh.

RESISTANCE TO RODENTS' BITES

An effective anti-burrowing solutions must resist the tearing force of the digging animals including their bites. **RENOMESH**, **RENOMESH BIO** and **RENOMESH GREEN** have an outstanding tensile strength resistance, from 35 to 60kN depending on the mesh size. These solutions are proven to be effective to rodents' bites: the steel wire thickness resists to bites, the double twist structure prevent propagation of wire breakage if any (unraveling).

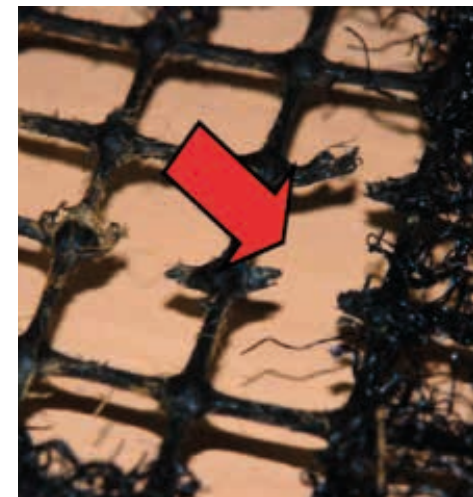


Due to their durability in water, synthetic material were also used in the past but proven to not be effective against rodents bites.

Test conducted at **Vienna University of Technology** on several types of barrier systems proven that steel mesh is the only way to create a barrier impenetrable to the strong bite of a beaver.



TECHNISCHE
UNIVERSITÄT
WIEN
Vienna University of Technology



RENOMESH is proven effective against the rodent's bite

UNRAVELING

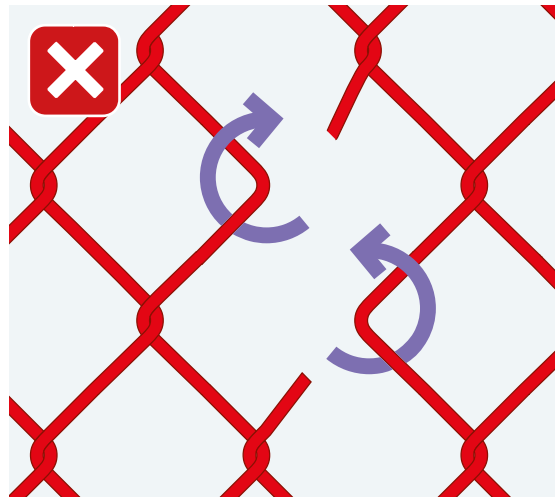
RENOMESH, **RENOMESH BIO** and **RENOMESH GREEN** are made of double twist wire mesh. Due to the characteristics of the double twist, the steel wire mesh can withstand the tearing force of sediments carried by the flow without unraveling in the event of wire breakage.

In case of an unlikely wire damage, the breakage does not propagate through the mesh thanks to geometrical structure of the double twist wire mesh that ensure a better load distribution.

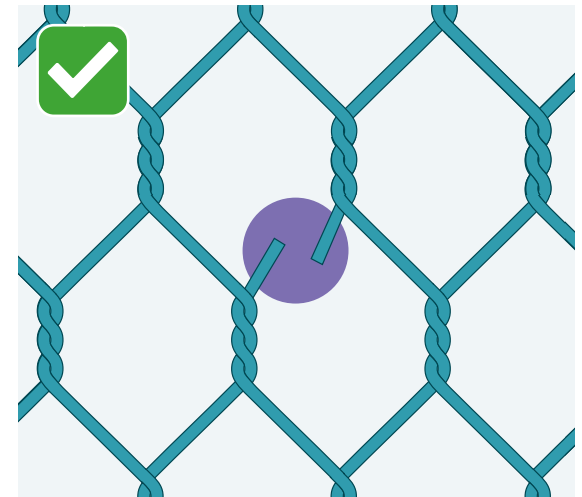
This reduces the risk of damages during the installation phase and due to vandalism.



The use of **RENOMESH BIO** and **RENOMESH GREEN** promote the establishment of vegetation thus maximising the adhesion of the anti-burrowing solution in the underneath soil. This leads to the creation of a monolithic layer and reduces even further the risk of wire breakage due to trunk and sediments carried by the flow.



Once a wire breakage occurs, the damage can propagate through the mesh.



In the unlikely event of wire breakage, the mesh does not unravel: the load is re-distributed across the mesh.

WIRE DURABILITY

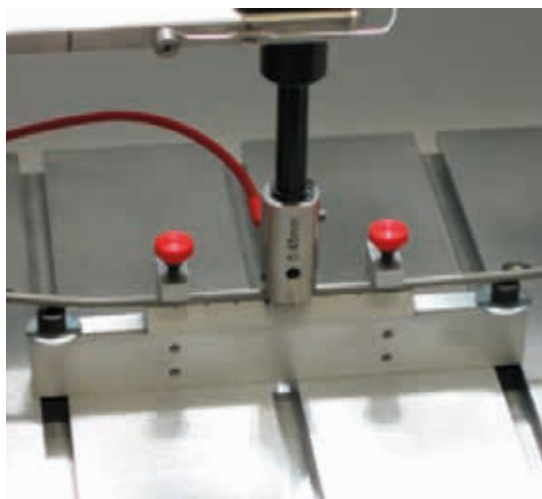
RENOMESH, RENOMESH BIO and RENOMESH GREEN are made from high quality steel wire, which is heavily galvanised to provide long term corrosion protection.

An **additional protective polymeric coating** is also applied for meshes that are to be used in

more aggressive environments, or where a longer design life is required. Our **polymer coated mesh** complies with the tests aimed to assure the longest durability: salt spray (**ISO 9227**), Kesternich (**ISO 6988**), abrasion resistance (**EN 60229**), UV resistance (**ISO 4892-3**), thus ensuring a working life of over 120 years (as per **EN 10223-3**).

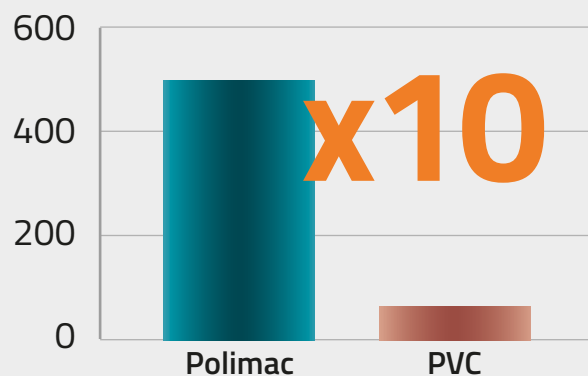
PoliMac®
WIRE PROTECTION FOR A CHANGING WORLD

RENOMESH Series is coated with **PoliMac®** coating, an inert polymeric compound which exhibits high abrasion resistance. **PoliMac®** is capable of withstanding the most severe application conditions including highly aggressive mechanical and chemical impact, long-term ultraviolet radiation and low temperature effects.



ABRASION TEST - ASTM A975-21

Number of cycles at the end of the abrasion test



As prescribed in international standards (**FHWA-NHI-10-024, EN 14475**), steel wire meshes installed in soil require a protective polymer coating to prevent corrosion and loss of mass; alternatively, in absence of outer polymer coating, minimum steel wire dia. of 8 mm should be used.



Test Specimen, before and after Salt Spray Test (ISO 9227)

INSTALLATION BENEFITS

1. PRELIMINARY STEPS

Double Twist steel wire mesh and erosion mats are delivered in rolled form and require very simple installation steps.

The high quality steel wire and the protective coating prevent damages during the installation activities.

Moreover, being more rigid, **RENOMESH BIO** and **RENOMESH GREEN** do not require topsoil cover, reducing the earth movement costs.

RENOMESH Series can be supplied in up to 100 m long rolls, thus optimising loading plans and dramatically reducing installation cost.

2. DT MESH SETTING

1 steel pin/m²

3. MESH TO MESH JUNCTION

