TeMa
Technologies
and Materials

Tefond T Evolution,
Tefond T Evolution Drain,
Tefond T Evolution HyperDrain

drainage and waterproofing systems

NATURAL AND ARTIFICIAL TUNNELS

drainage and waterproofing systems

Introduction

The world of tunnels represents one of the civil engineering fields that has mainly required the commitment and courage of man in the precision adjustment of the current constructive technologies. However, there is still much to be discovered with regard to usable materials and in relation to the laying methods.

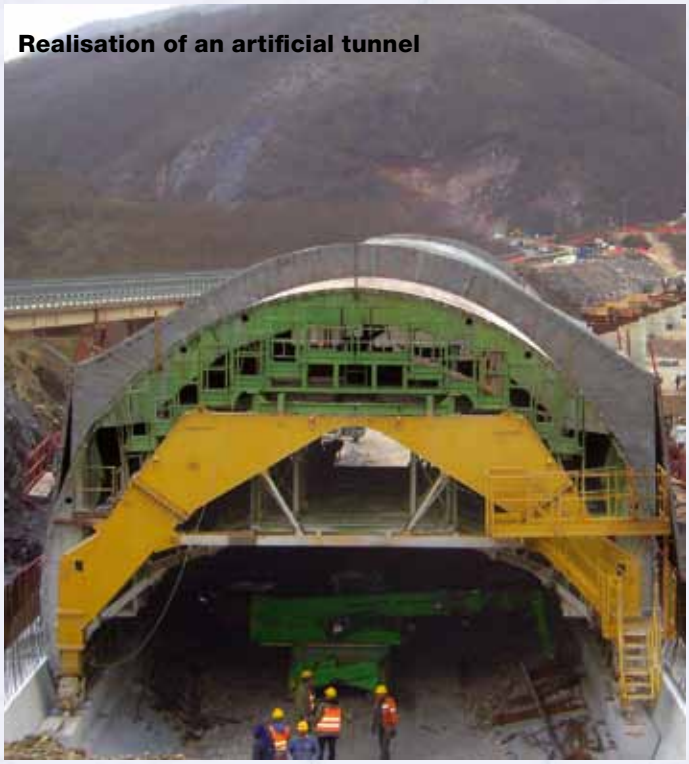
Tema, leading company in the waterproofing, draining and reinforcement systems of soils, has studied, developed, realised and installed a range of patented products, specific for natural and artificial tunnels:

- **Tefond T Evolution;**
- **Tefond T Evolution Drain;**
- **Tefond T Evolution HyperDrain.**

The large innovation enabling a considerable economic saving in terms of laying of materials, is constituted by the combination of two functions still separated to date: **waterproofing and drainage.**
Furthermore, the draining performances of our products are 500 to 1200 times greater compared to the currently used systems (TNT of 500 g/sq m).

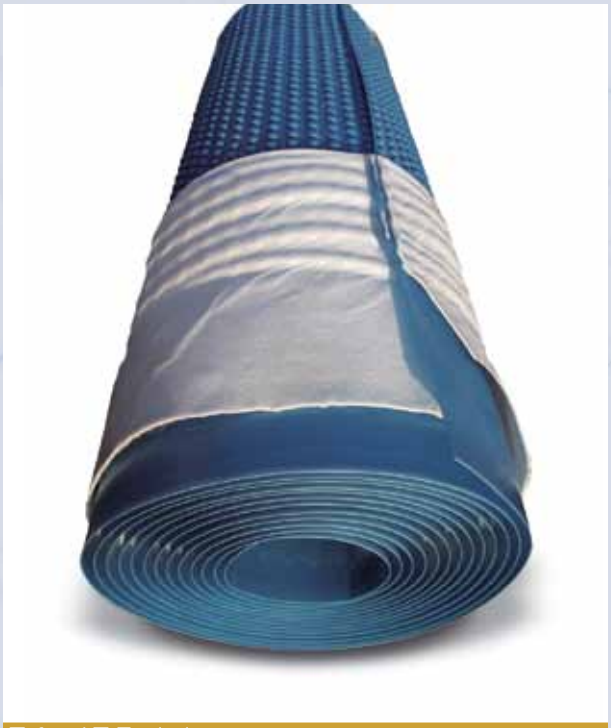
These state-of-the-art solutions, with all its advantages, have revolutionized the construction methods, contributing to raise the general level of research in this fascinating sector.

Realisation of a natural tunnel

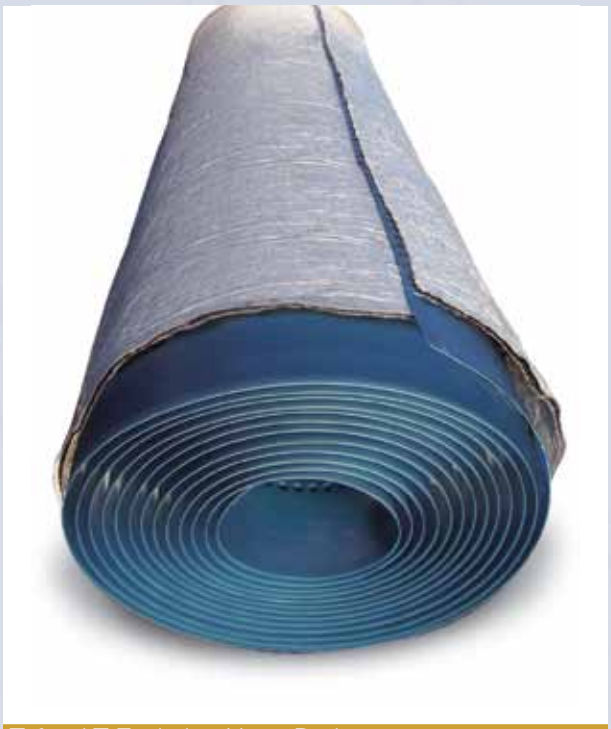


Realisation of an artificial tunnel

Natural tunnels

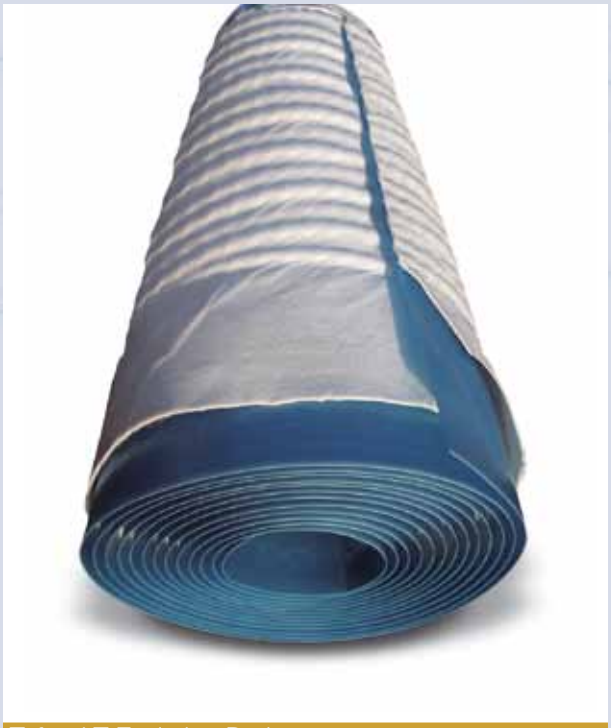


Tefond T Evolution



Tefond T Evolution HyperDrain

Artificial tunnels



Tefond T Evolution Drain

Tefond T Evolution HyperDrain

The Standards of reference

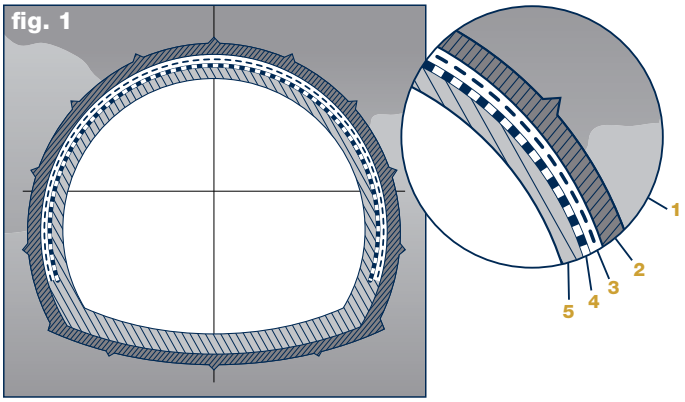
EN 13491 **Geosynthetics with barrier function. Features requested for the use as barrier against fluids in the construction of tunnels and underground structures.**

General

The main function of the geosynthetics with barrier function, when used for construction of tunnels and underground structures, consists in preventing or reducing the flow of the fluid through the structure.
This document does not deal with damaging during installation.

Natural tunnel application not pressurized

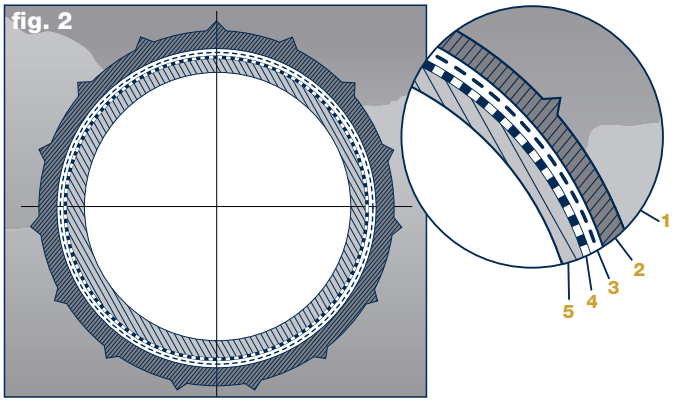
Application where the geosynthetic with barrier function is used as barrier on its own against infiltrations (dampness). **fig. 1**



1 rock
2 shotcrete
3 geotextile
4 geosynthetic with barrier function
5 metal reinforced concrete

Natural tunnel application pressurized

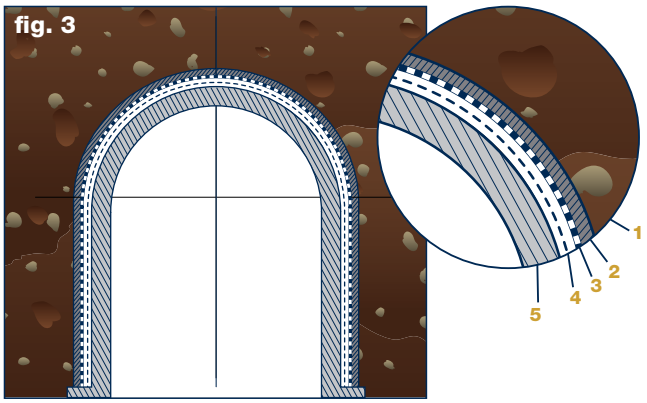
Application where the geosynthetic with barrier function is used as barrier against pressurized water. **fig. 2**



1 rock
2 shotcrete
3 geotextile
4 geosynthetic with barrier function
5 metal reinforced concrete

Artificial tunnel application not pressurized

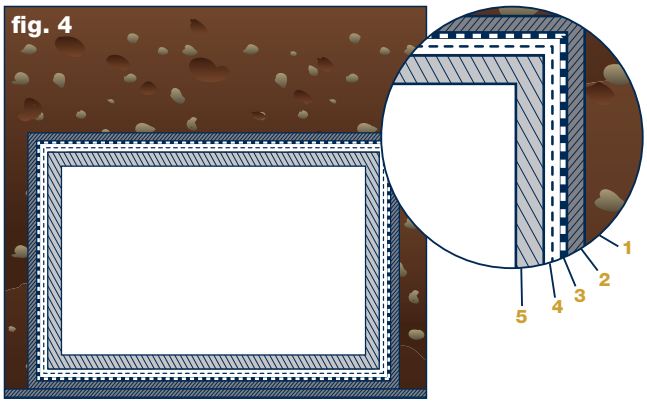
Application where the geosynthetic with barrier function is used as barrier on its own against infiltrations (dampness). **fig. 3**



1 soil
2 protection layer
3 geosynthetic with barrier function
4 geotextile
5 metal reinforced concrete

Artificial tunnel application pressurized

Application where the geosynthetic with barrier function is used as barrier against pressurized water. **fig. 4**



1 soil
2 protection layer
3 geosynthetic with barrier function
4 geotextile
5 waterproof concrete

EN 13252 Geotextiles and similar products.
Features requested for use in draining systems.

The main functions of the geotextiles and similar products used in draining systems are filtering, separation and drainage.

Materials compatibility with the Standards of reference

During designing of a tunnel, whether natural or artificial, particular attention is given to checking the compatibility of the chosen materials with the specific Standard of reference.
The works management has the obligation to demand CE mark of materials; also, it must check that the latter refers to the correct Standard (as application and as function).
Reported below is the regulatory framework that regulates the use of certain materials with a specific function (barrier, drainage) in **application** in tunnels and underground structures.

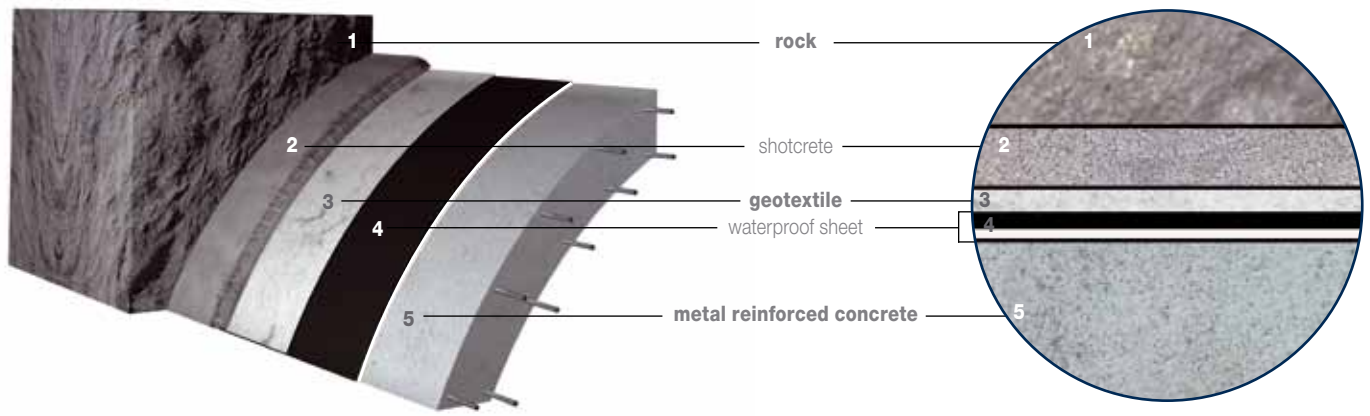
ELEMENT	FUNCTION	APPLICATION	STANDARD OF REFERENCE
Tefond T Evolution	**Waterproof barrier**	**Tunnels and underground structures**	**EN 13491**
Tefond T Evolution HyperDrain	**Waterproof barrier**	**Tunnels and underground structures**	**EN 13491**
Tefond T Evolution Drain	**Waterproof barrier**	**Tunnels and underground structures**	**EN 13491**
Geomembrane in PVC	**Waterproof barrier**	**Tunnels and underground structures**	**EN 13491**
Bentonite Geocomposite	**Waterproof barrier**	**Tunnels and underground structures**	**EN 13491**
Bituminous membrane	**Waterproof barrier**	**Tunnels and underground structures**	**EN 13491**
Tefond T Evolution	**Draining**	**Tunnels and underground structures**	**EN 13252**
Tefond T Evolution HyperDrain	**Enhanced drainage**	**Tunnels and underground structures**	**EN 13252**
Tefond T Evolution Drain	**Draining**	**Tunnels and underground structures**	**EN 13252**
TNT 500 g/m2	**Draining**	**Tunnels and underground structures**	**EN 13252**

Natural tunnels

drainage and waterproofing systems of arch

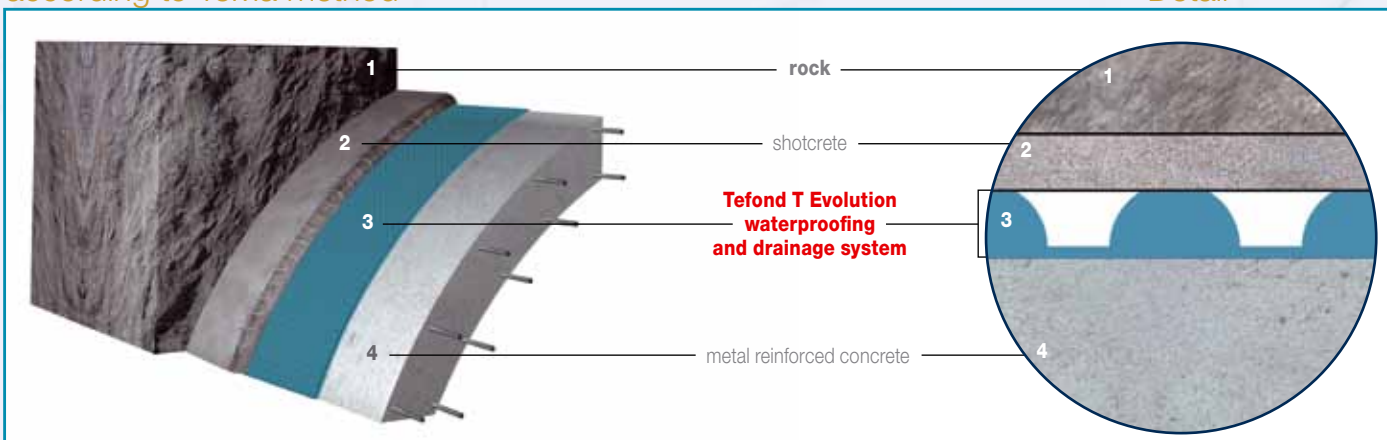
Traditional type section

Detail



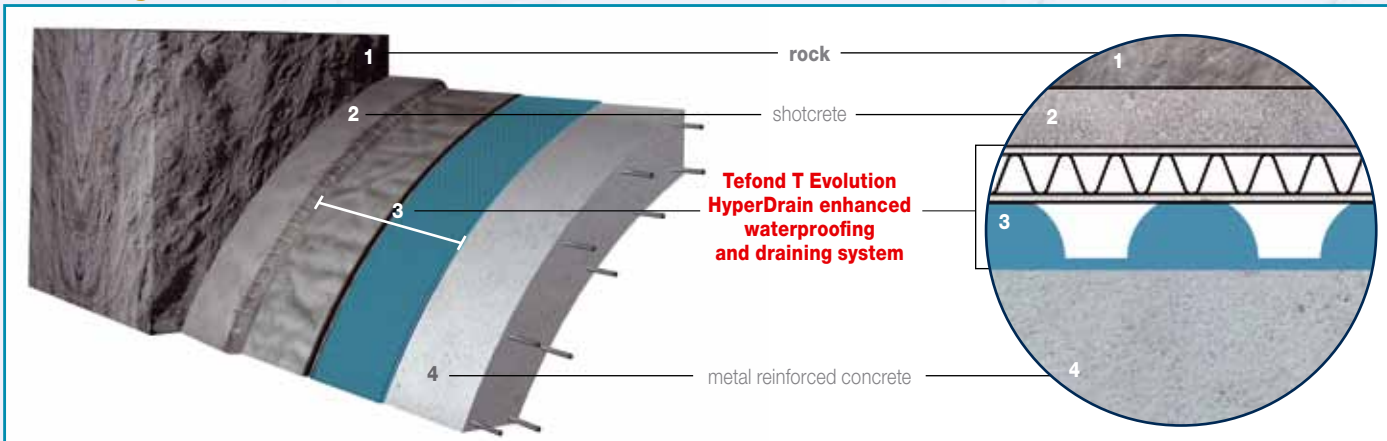
Section type
according to TeMa method

Detail



Section type
according to TeMa method

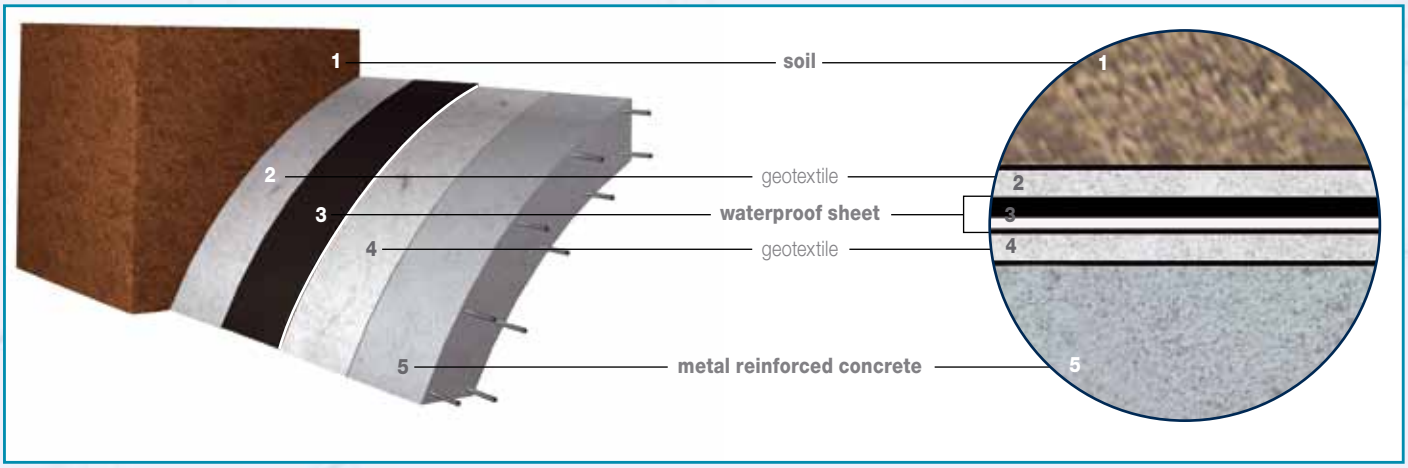
Detail



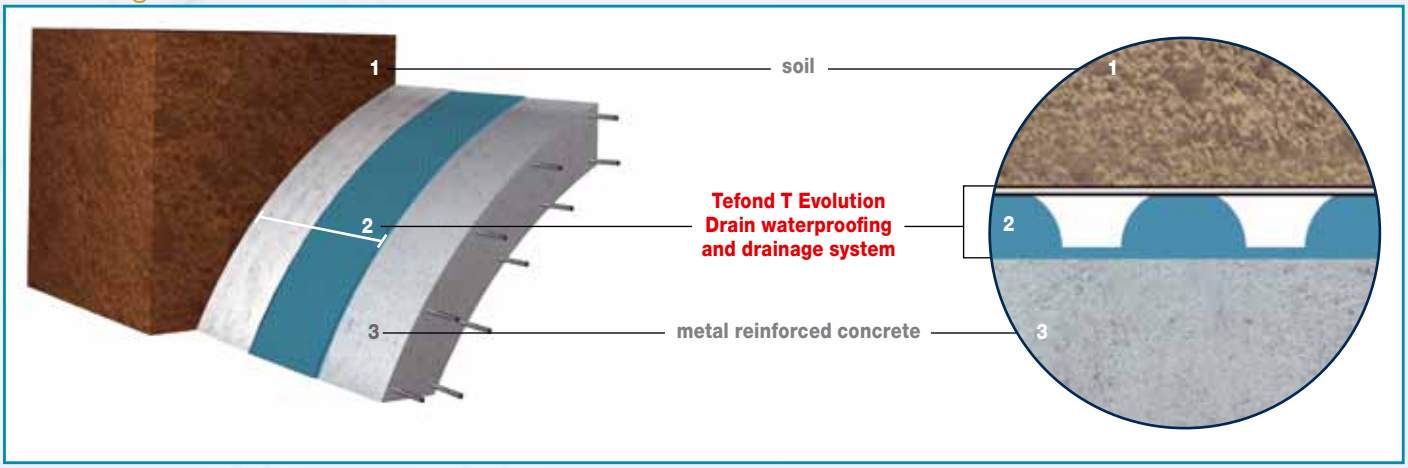
Artificial tunnels

drainage and waterproofing systems of arch

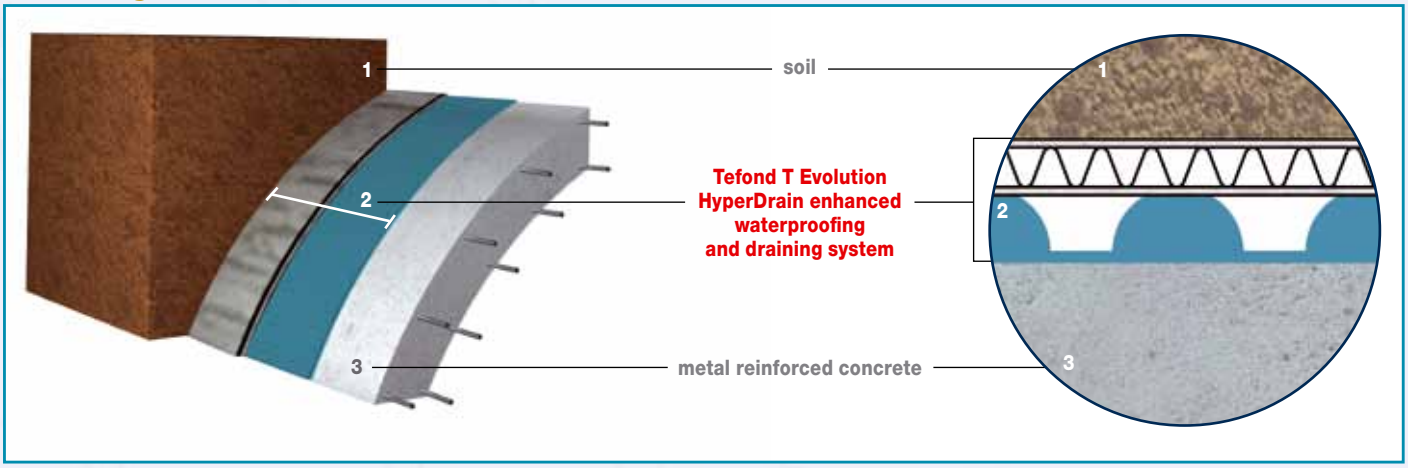
Traditional type section



Section type
according to TeMa method

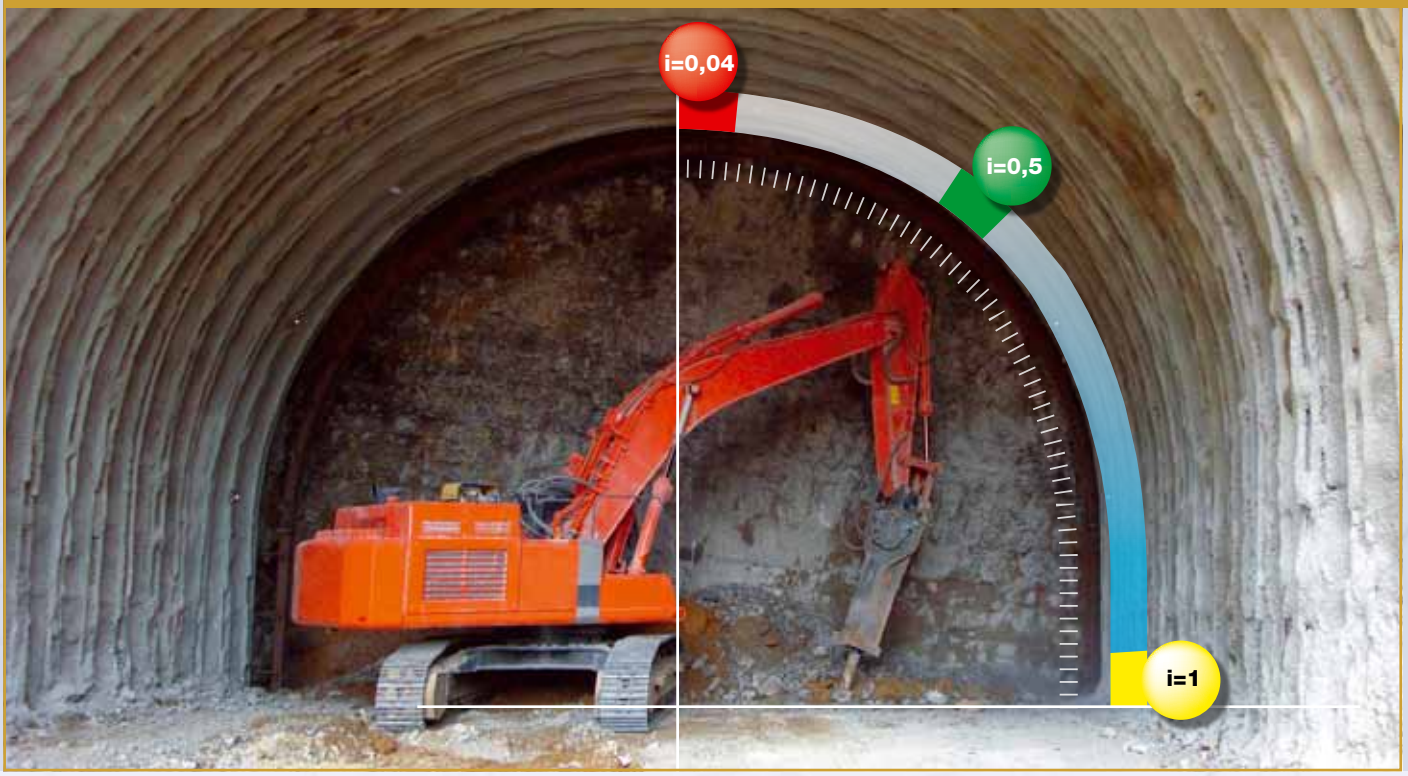


Section type
according to TeMa method

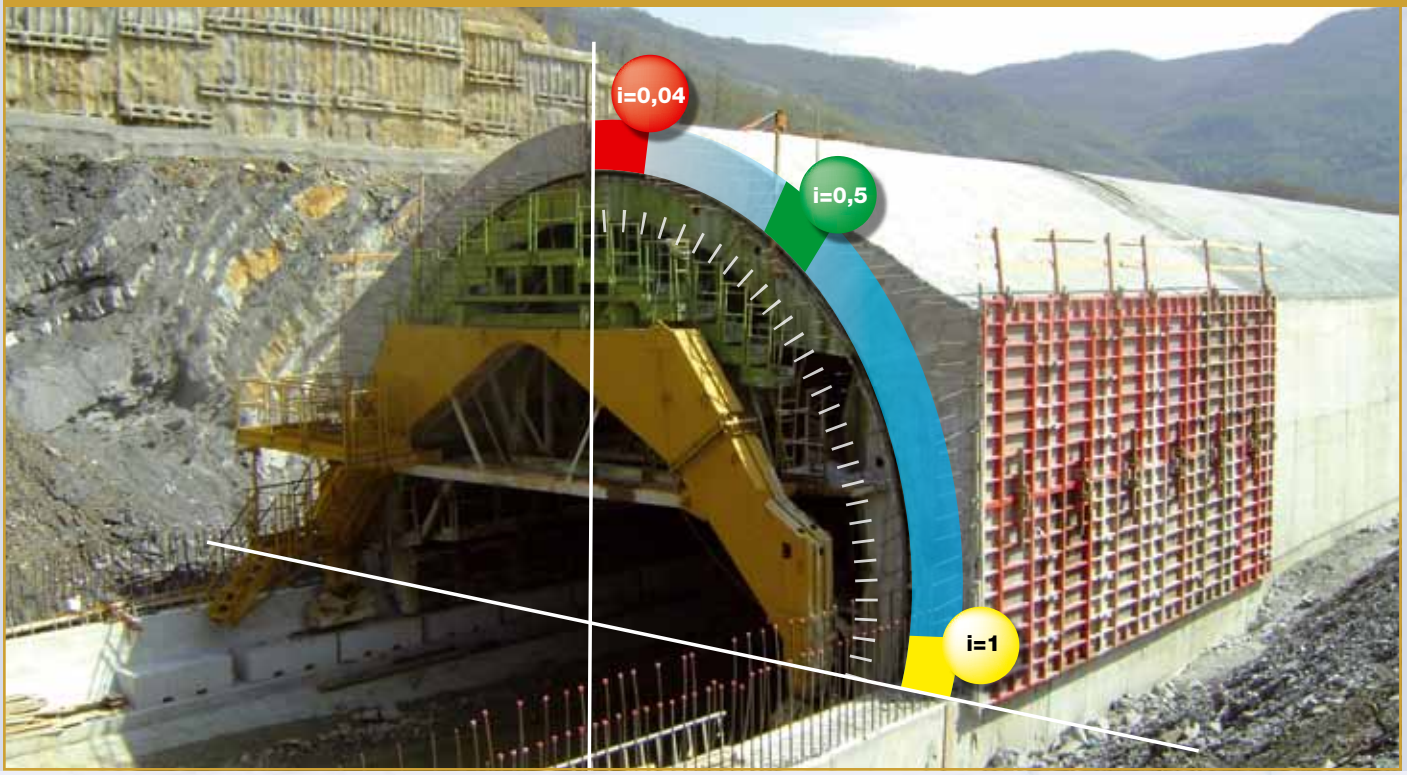


Highly draining performances

NATURAL TUNNELS

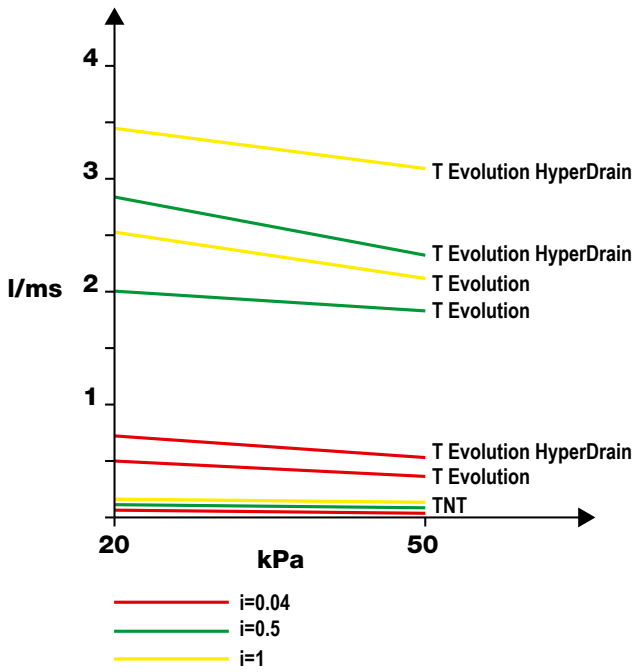


ARTIFICIAL TUNNELS



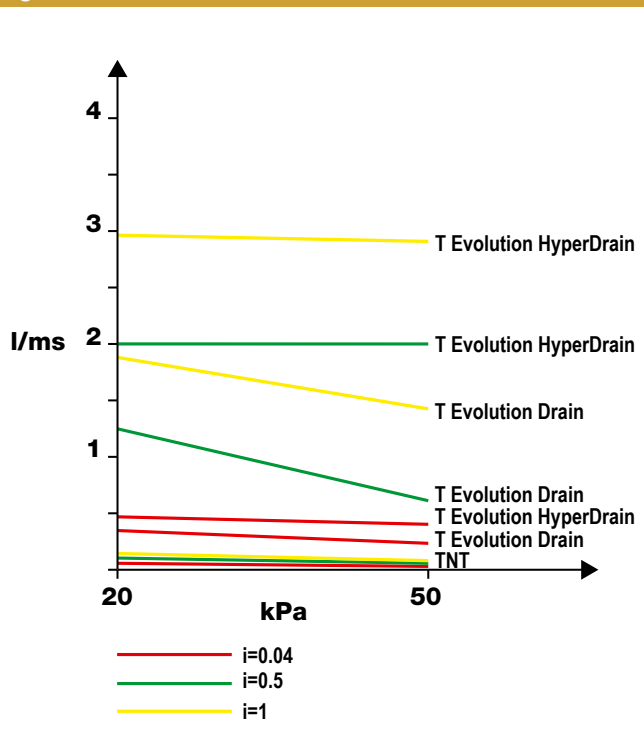
Rigid/rigid contact

contact R/R load 20kPa	i=0.04	i=0.5	i=1
TNT 500 g/sqm	0,00081	0,00234	0,00468
Tefond T Evolution	0,50	2	2,55
Tefond T Evolution HyperDrain	0,706	2,831	3,447
contact R/R load 50kPa	**i=0.04**	**i=0.5**	**i=1**
TNT 500 g/sqm	0,00073	0,00211	0,00432
Tefond T Evolution	0,4	1,8	2,2
Tefond T Evolution HyperDrain	0,544	2,369	3,171



Rigid/soft contact

contact R/S load 20kPa	i=0.04	i=0.5	i=1
TNT 500 g/sqm	0,00073	0,00211	0,00421
Tefond T Evolution Drain	0,296	1,274	1,887
Tefond T Evolution HyperDrain	0,471	2,040	2,933
contact R/S load 50kPa	**i=0.04**	**i=0.5**	**i=1**
TNT 500 g/sqm	0,00066	0,0019	0,00389
Tefond T Evolution Drain	0,207	0,522	1,455
Tefond T Evolution HyperDrain	0,437	2,009	2,902



Advantages

1. **Highly flexible.**
2. **Without plasticisers or solvents.**
3. **In case of fire does not emit toxic substances, like chlorine and hydrochloridic acid.**
4. **Exceptional resistance to corrosive liquids.**
5. **Greater lightness: the rolls are light therefore easy to handle.**
6. **2.4 to 4 m wide rolls with consequent lower number of welding and, therefore, less possibility of water infiltrations.**
7. **Excellent break-resistant values and relative elongation.**
8. **Fast laying as it does not require TNT and washers or PVC straps.**
9. **Excellent flexibility values with cold.**
10. **Excellent resistance values to punching.**
11. **Possibility of laying also in presence of percolating water.**

Realisation of a natural tunnel

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Theme: technologies and materials for the building sector and the environment.

There are two fundamental aspects in the realisation of building works and environmental engineering interventions: the visible one, mainly aesthetical, and the non-visible one, involving structural, protection, maintenance and safety elements. Tema has been dealing with the latter aspect for over 10 years, distinguishing itself for the original application solutions (often very competitive) and for the technological innovations and the use of new materials.

Tema uses a modern production system with establishments in Italy, Spain, Turkey, Romania and Russia. It supplies its technologies in over 60 countries where it is a market protagonist with solutions and products for drainage and insulation in the residential and civil building sectors.

Also very important are the innovative solutions conceived for large environmental intervention work, where Tema proposes the widest and most complete range of draining geocomposites and antierosion three-dimensional geomats and reinforcement geogrids.

Tema also distinguishes itself for the continuous research of new products, the active involvement of designers and companies, the support to clients during the realisation phases.

On cover: artificial tunnel in Feltre - Belluno

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