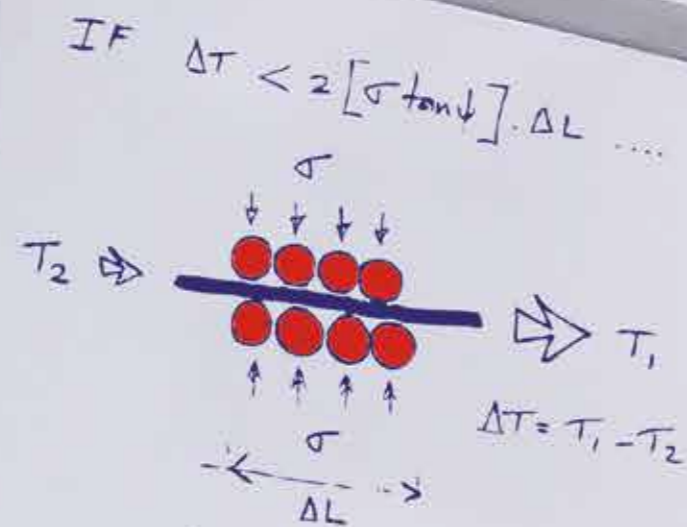


**TERRE ARmee**



... THEN no sliding occurs  
 AND, IF reinforcements are judiciously placed in a granular mass, THEN the whole will behave as a composite mass exhibiting an anisotropic cohesion related to the strength of the reinforcement  
 ..... Henri Vidal

#### ONCE UPON A TIME

In 1963, French engineer and architect Henri Vidal files the patent for Reinforced Earth®. This brand new technique associates a selected and controlled backfill, together with reinforcements and facing panels, thus creating a sustainable composite material. The technique has many advantages. The structure requires a limited land take, can be adapted to all kinds of terrain, withstand heavy loads and resist to earthquakes. Reinforced Earth® is also a very cost-effective solution and can be implemented quickly.

## TERRE ARMÉE

Designer and supplier of civil engineering solutions that retain, cross, protect and strengthen.

Terre Armée has been designing and supplying innovative geotechnical engineering structures and reinforced backfill solutions for more than half a century. Having invented the Reinforced Earth® technique with more than **100,000 structures completed around the world**, our Group sets the standard.

#### OUR VISION

Terre Armée rolls out its leading technologies to serve clients' projects, from the simplest to the most exceptional. Guided by our focus on innovation and our culture of excellence in client relations, we offer suitable, durable solutions. We build on our global expertise, which is applied by our local companies, to develop new applications and to address the challenges of the future.

**Over 70 million** sq. meters built worldwide

#### INNOVATING

Innovation, a key part of our process, enables us to meet our clients' needs.

#### DESIGNING

Our engineers and technicians design structures that are both technically efficient and durable.

#### IMPLEMENTING

We align our resources and teams to ensure the success of each project.

## INNOVATION & EXPERTISE

### Designing solutions tailored to each project

Our design offices build on the Group's accumulated experience. Our civil and geotechnical engineers design optimum solutions to ensure the structure reliability and durability. They are guided by the same visionary spirit that marked the inception of the Terre Armée company.

#### NETWORKED EXPERTISE

Thanks to its international presence, Terre Armée is able to capitalise on its large network of engineers.

The group's Engineering Department coordinates the flow of knowledge and experience between the design offices of the various companies. It marshals the network's expertise to provide technical support for the subsidiaries.

#### ADDRESSING THE CHALLENGES OF THE FUTURE

The Innovation Department handles research and development. It innovates to meet the project-specific needs of the subsidiaries' design offices and conducts an in-depth market and technology watch to anticipate future trends in the civil engineering sector.

The Group has developed some 100 major inventions, which are covered by 1,500 patents filed around the world.



**1,500**  
patents filed  
worldwide

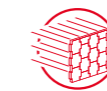
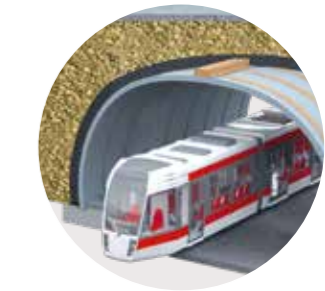
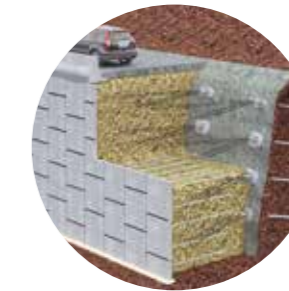


## TECHNICAL SOLUTIONS AND SERVICES

### Optimising the performance of each structure

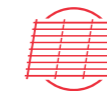
Terre Armée offers its clients optimised state-of-the-art solutions. Our baseline services include structure design, supply of the specific components and training of the teams in charge of construction. This ensures overall project consistency and success. Since inventing Reinforced Earth®, we have developed a broad range of technical solutions adapted to a wide variety of situations.

#### Our techniques



**REINFORCED EARTH®**  
The original Reinforced Earth® technique

The technique combines three elements – controlled backfill, strong reinforcements and modular facing panels – to form a durable retaining structure.



**ARMALYNK®**  
A high-strength PET geogrid

The geogrid is used for various basal reinforcement and challenging ground stabilization needs.



**TECHSPAN®**  
The high-quality custom-designed arch

Our soil expertise and finite element analysis were used to develop this precast concrete arch technique, a two- or three-hinged funicular curve-shaped system.



**T-WALL®**  
The T-module retaining wall

These precast concrete units are stacked to build gravity retaining walls.



**TECHWALL®**  
The precast concrete retaining wall

This consolidated counterfort solution meets the requirements of walls built on footings.



**TECHREVTMENT™**  
An alternate and durable solution for erosion protection

It is composed of fabric form concrete mattresses for erosion control and scour protection.

## MAJOR STAGES OF A PROJECT

Our teams are involved throughout the project, from the preliminary design, to engineering and construction.

### 1 DESIGN

The Terre Armée design office carries out an initial technical analysis and draws up a preliminary estimate based on the geotechnical conditions and the features of the engineering structure.



### 2 BID

The sales team coordinates with the design office to propose a detailed drawing of the structure, an associated construction timeline and a precise cost estimate.



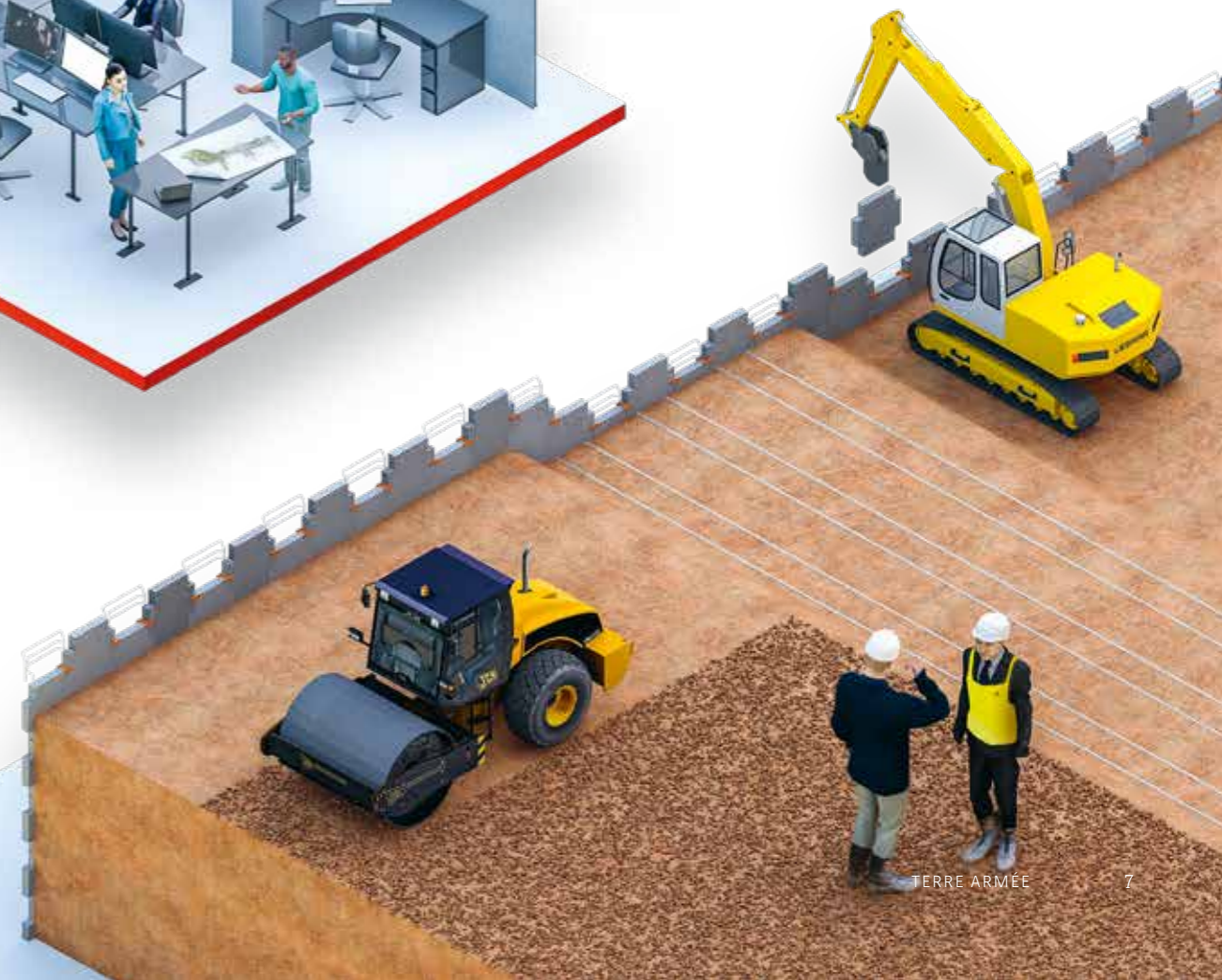
### 3 CONSTRUCTION SURVEY

Following signature of the contract, the design office produces the drawings, engineering calculations and execution methods.



### 5 CONSTRUCTION SERVICES

The components are delivered to the jobsite. The Operations team trains the contractor's personnel in building the structures according to design office specifications. Our team remains available to provide technical expertise.



### 4 MATERIALS SUPPLY

The Operations department takes over for the design office and manages the supply of components directly.



## RETAIN



## CROSS



## PROTECT



## STRENGTHEN



## BUSINESS LINES

Our technical solutions are defined by four functions corresponding to the application of the structure to be designed:

**RETAIN, CROSS, PROTECT, STRENGTHEN.**

### RETAIN

#### Retaining structures

As the inventors of Reinforced Earth® and leaders in the soil reinforcement sector, we offer solutions for all retaining projects.

### CROSS

#### Crossing structures

Our customised crossing solutions are used to build bridge abutments, bridges and tunnels under backfill.

### PROTECT

#### Protective structures and solutions

Our solutions help protect people, infrastructure and the environment from natural and industrial hazards.

### STRENGTHEN

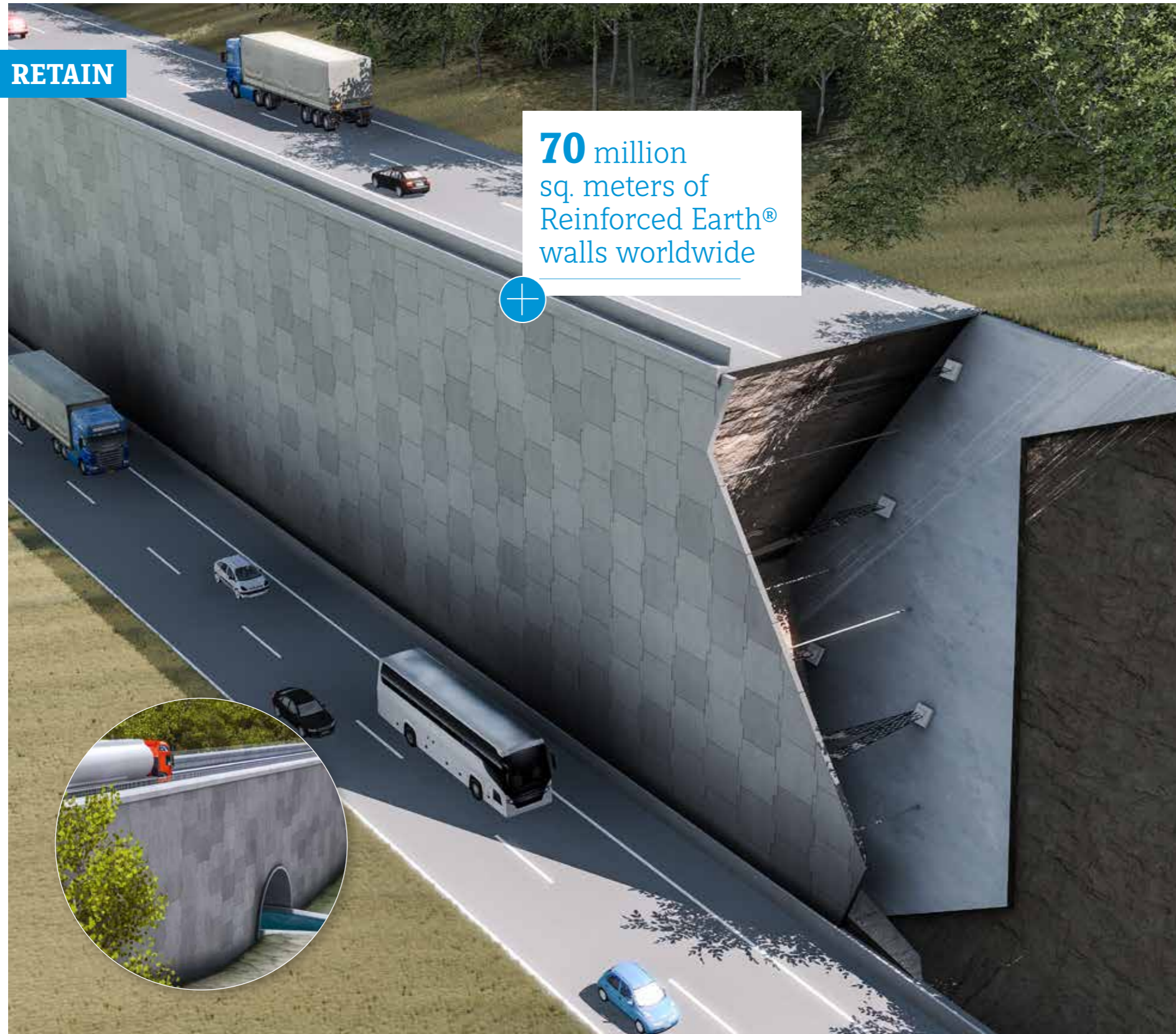
#### Strengthening solutions

We design solutions and supply materials that are used for basal reinforcement and soil stabilization applications.



RETAIN

70 million sq. meters of Reinforced Earth® walls worldwide



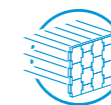
road widening  
retaining walls **RETAIN** dams  
loading docks reinforced embankments  
access ramps grade separations

## Retaining structures

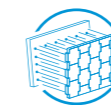
Building on its one-of-a-kind expertise in soil-structure interaction, the Terre Armée Group designs a wide variety of retaining structures.

Our techniques can be used to build all types of structures corresponding to the **RETAIN** function, using many types of facing and reinforcement, including Reinforced Earth® retaining walls and reinforced embankments.

### OUR TECHNIQUES



**Reinforced Earth®**  
Since the technique was invented, our engineers have continued to further develop it, notably by increasing the height of structures and designing new reinforcement systems to accommodate a wide variety of backfill materials.



**TerraLink™**  
This complementary technique combines excavation and backfill to build Reinforced Earth® walls to existing walls or other retaining structures such as soil nail stabilised embankments.



**TechWall®**  
This precast concrete retaining wall system consists of full-height panels. Each panel is combined with a counterfort.



**T-Wall®**  
This precast concrete retaining wall system is made up of T-shaped units with a rectangular facing and a toothed stem.





**REPUBLIC  
OF MACEDONIA**

*B2 Viaduct on the E75 motorway*

The B2 viaduct in the southern part of the country carries the E75 motorway, which links the cities of Demir Kapija and Smokvica, across the Vardar River and a railway line. Terre Armée designed the solution that facilitates access to the structure, which is made up of 25 meter high Reinforced Earth® retaining walls.



**CROSS**



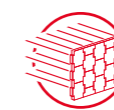
tunnel extensions arch bridges  
 wildlife crossings **CROSS** underpasses  
 overpasses cut-and-cover  
 tunnels bridge abutments culverts

## Crossing structures

To cross natural obstacles such as watercourses and valleys, or man-made roads and railways, Terre Armée designs both overhead and underground crossing solutions.

Our techniques are used to build all types of structures to meet the **CROSS** function, such as reinforced backfill bridge abutments for overhead crossings, as well as cut-and-cover tunnels, culverts and underpasses for underground crossings.

### OUR TECHNIQUES



**Reinforced Earth®**  
 Our historic Reinforced Earth® technique is used in a broad range of crossing solutions, including bridge abutments.



**TechSpan®**  
 Our precast concrete arch system is used to build arch structures under backfill. The precast concrete segments are delivered to the jobsite and assembled on the spot.



**TechBox®**  
 The rectangular box system under backfill is made up of modular precast concrete contiguous wall and cover elements. They are delivered to the worksite and assembled on the spot.





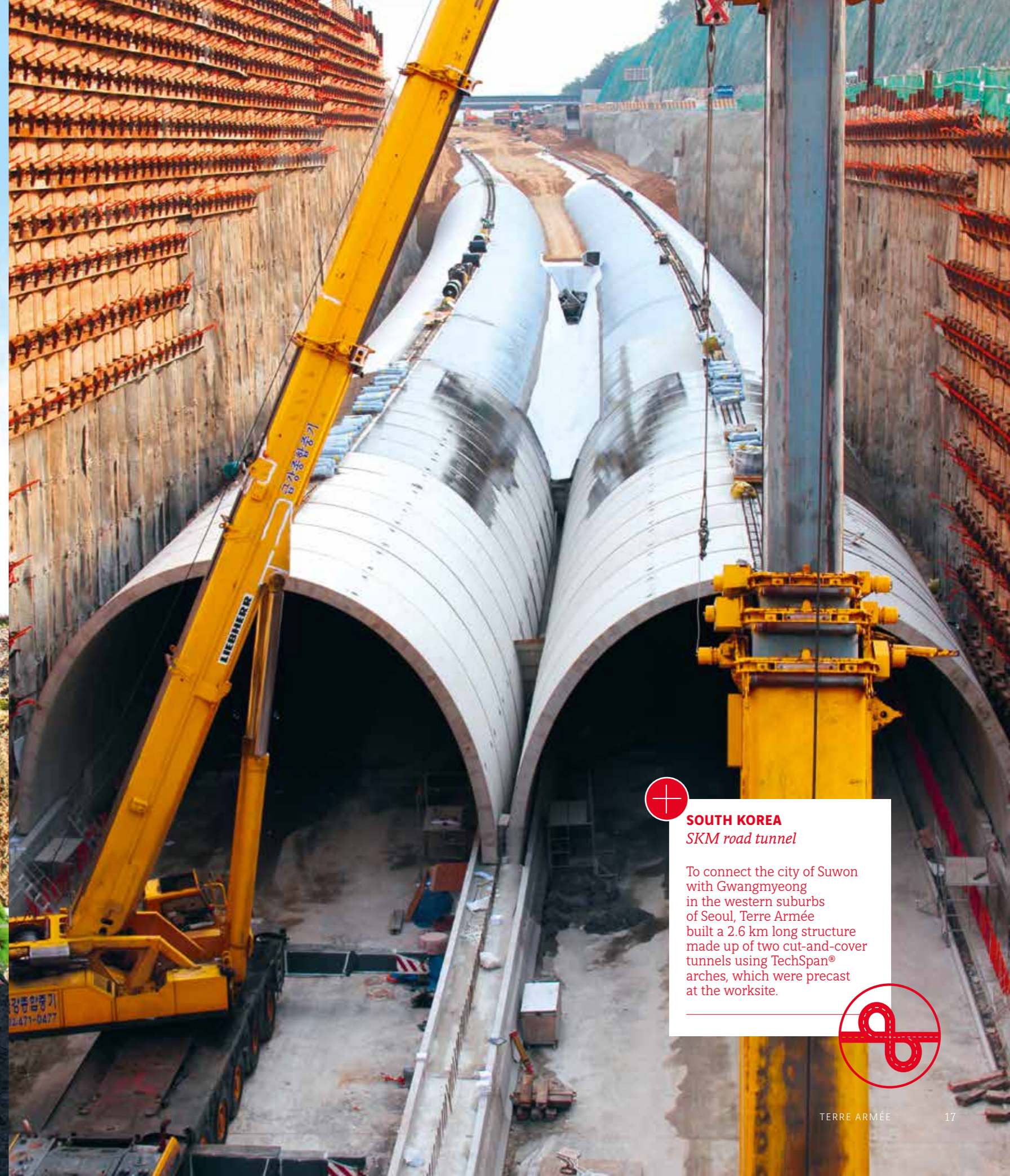


**UNITED KINGDOM**  
*Heads of the Valleys*

The A465 motorway in southern Wales has been widened to a dual two-lane carriageway. Terre Armée designed and supplied the highest TechSpan® arch ever built in the United Kingdom (with a height of 9.6 meters), which is also the TechSpan® arch with the highest volume of backfill, due to its location on a slope.



© Marcus Brierley



**SOUTH KOREA**  
*SKM road tunnel*

To connect the city of Suwon with Gwangmyeong in the western suburbs of Seoul, Terre Armée built a 2.6 km long structure made up of two cut-and-cover tunnels using TechSpan® arches, which were precast at the worksite.



# PROTECT



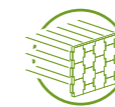
avalanche barriers  
 blast protection walls rock shed structures  
 embankments **PROTECT** slope stabilisation  
 protective berms breakwaters

## Protective structures and solutions

Terre Armée designs structures to protect people, infrastructure and the environment from natural and industrial hazards.

Our range of solutions corresponding to the **PROTECT** function provide protection from **natural hazards** such as avalanches, earthquakes, tsunamis, flooding, rockfalls, coastal erosion and landslides. We also design specific solutions to provide protection from **industrial hazards** such as explosions and polluted fluids.

### OUR TECHNIQUES



**Reinforced Earth®**  
Due to its flexibility and resilience, our historic technique can withstand earthquakes and absorb high levels of energy in rockfalls and explosions.



**TechSpan®**  
Our precast concrete arch system protects covered road sections from rockfalls and landslides.



**TechBox®**  
Our precast concrete boxes under backfill are recommended as a way to protect road and railway sections exposed to rockfalls.



**TechRevetment™**  
An alternative and durable solution composed of fabric form concrete mattresses for erosion control and scour protection.





**ICELAND**  
*Seyðisfjörður*  
*avalanche barrier*

The village of Seyðisfjörður lies encircled by three mountains at the bottom of the longest fjord in the eastern part of the island. To protect it from avalanches, Terre Armée designed a barrier built at an altitude of 600 meters. The 20 meter high Reinforced Earth® structure with welded wire mesh facing covers an area of nearly 7,000 sq. meters. It comprises two walls designed to deflect and retain snow, which are inclined at angles of 34° and 76° respectively.



# STRENGTHEN



Embankment over soft soil



Embankment over rigid inclusions



Void bridging

## Void bridging

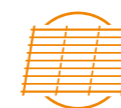
embankments over soft soil **STRENGTHEN** piled embankments  
soil stabilization basal reinforcements  
reinforcement geosynthetics load transfer platforms  
soil reinforcement high performance welded geogrid

## Strengthening solutions

The **STRENGTHEN** function covers a wide range of engineered solutions such as embankments over soft soils, piled embankments, embankments over voids and soil stabilization.

Terre Armée combines engineering expertise and high-end quality products to deliver safe, sustainable and durable infrastructure.

### OUR SOLUTIONS



**ArmaLynk®**  
A high-strength PET geogrid used for various basal reinforcement and challenging ground stabilization needs.



**ArmaGrid®**  
Full-service approach for procuring biaxial and uniaxial, polyester (PET) and polypropylene (PP) geogrids.



**ArmaWeb®**  
Expandable, cellular soil confinement solution to design or install a durable system for permanent or temporary control of erosion, stabilizing subgrade soils or for controlled load distribution.





**PERU**

*The Costa Verde Road Project*

To generate a faster access to the airport, the Costa Verde Road has been widened. Reinforced Earth designed, supplied 22,500 sq. meters of Reinforced Earth® walls and supplied the geosynthetic geogrid used to support and distribute the pressures generated by the walls, with a height of up to 20m.




-  Airports
-  Dams & Reservoirs
-  Energy
-  Oil & Gas
-  Industry
-  Property development
-  Defence
-  Mines & Quarries
-  Environment
-  Ports & Coastal sites
-  Railways
-  Inland Waterways
-  Roads & Motorways
-  Sports & Recreation
-  Waste management
-  Water management



**FRANCE**  
*South Europe Atlantic high-speed line*

For the SEA HSL linking Tours and Bordeaux, Europe's largest railway construction project, Terre Armée completed a world first: reinforced backfill retaining walls under railway lines carrying high-speed trains travelling at a rate of speed of 352 km/h. The innovation involved construction of 20 Reinforced Earth® structures. Of these, 17 support railway tracks. The highest is 12.70 meters at the end of a grade separation. Six TechSpan® structures were also built as part of this project.

Scan this code to find out more about the SEA HSL structures designed and built by Terre Armée.



## APPLICATIONS

Terre Armée designed structures are suitable for a wide variety of uses.

The **RETAIN, CROSS, PROTECT, STRENGTHEN** business lines address the issues faced by our clients across all activity sectors.

From roads to railways, oil and gas, mining, airports and coastal protection, our retaining, crossing, protective structures and strengthening solutions cover a wide variety of sectors. They help to roll out transport systems, improve the living environment and boost economic development while keeping people safe and protecting the environment.

Around the world, the Terre Armée Group has helped to build more than 100,000 structures of all sizes, from the very small to the spectacularly large.



## Airports

### RUNWAYS TAKE OFF

Terre Armée delivers solutions for airport expansion projects. The Terre Armée technique requires a limited land take. It overcomes geotechnical obstacles within the airport perimeter, such as watercourses or coastlines. Our structures are able to withstand the large dynamic loads generated

by wide-bodied aircraft such as the Airbus A380 and the Boeing 777. Lastly, the facings of these structures have an attractive finish. Access ramps, bridge abutments and retaining walls can therefore be easily blended into the urban landscape.

#### UNITED STATES

##### Fort Lauderdale International Airport

For the Florida airport enlargement project, and more particularly for the extension of the south runway, Terre Armée designed and supplied 53,000 sq. meters of 19 meter high Reinforced Earth® walls.



#### SWAZILAND

##### Mbabane junction

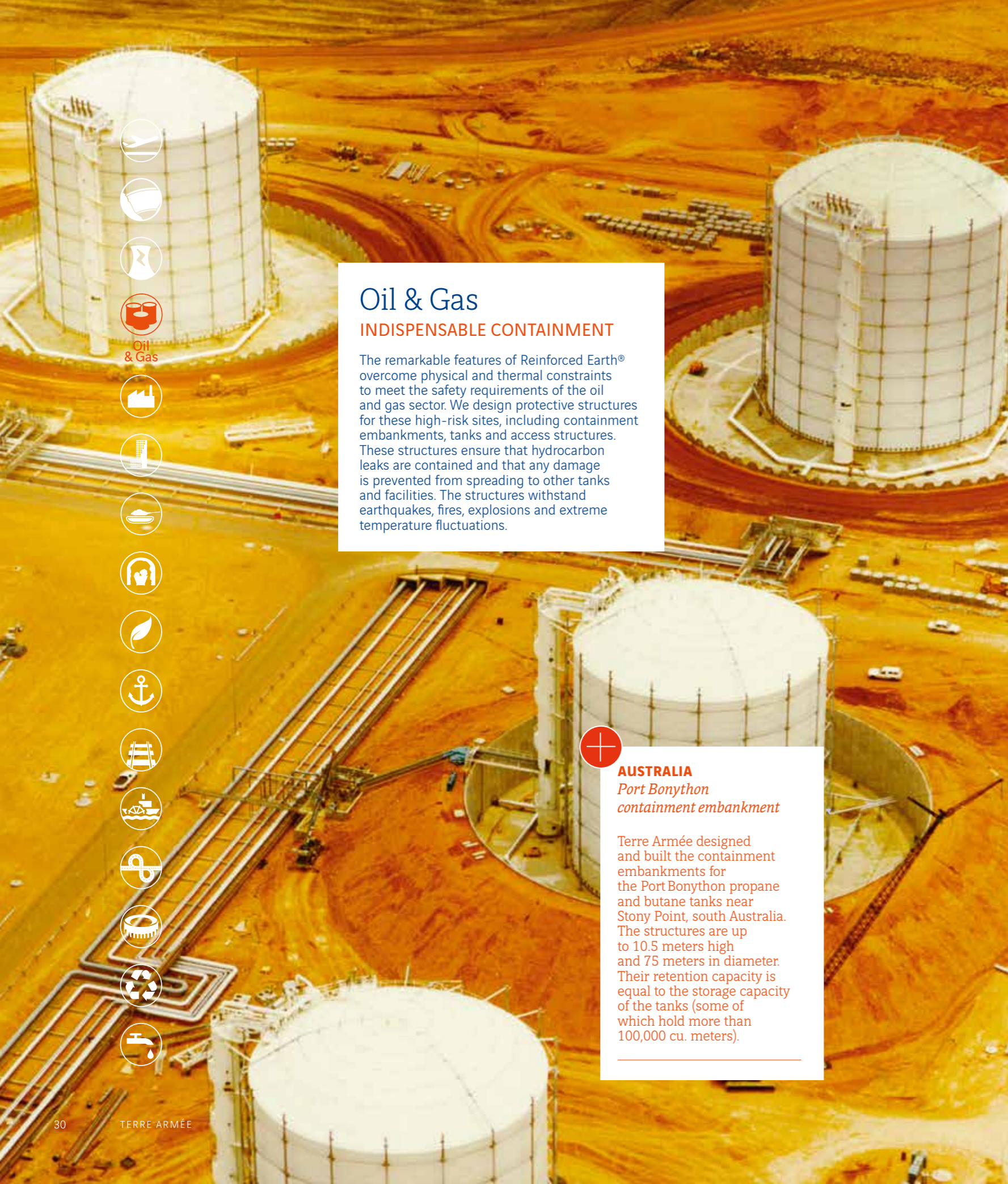
The motorway bypass in the capital of Swaziland is 12 km long. For this major infrastructure project, Terre Armée designed and supplied 18 retaining walls with a height of more than 30 meters, and 16 bridge abutments. The combined surface area is 36,000 sq. meters.



## Roads & Motorways

### OPEN ROAD TO STABILITY

Road and motorway structures constitute the historic Reinforced Earth® application. The technique can be readily adapted to rugged and unstable terrain and has been used to develop a large number of roads. Retaining walls are blended into the mountainous, coastal or urban environment. Reinforced Earth® is also used to build other types of road structures such as bridge abutments, junctions, access ramps and viaducts.



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## Oil & Gas

### INDISPENSABLE CONTAINMENT

The remarkable features of Reinforced Earth® overcome physical and thermal constraints to meet the safety requirements of the oil and gas sector. We design protective structures for these high-risk sites, including containment embankments, tanks and access structures. These structures ensure that hydrocarbon leaks are contained and that any damage is prevented from spreading to other tanks and facilities. The structures withstand earthquakes, fires, explosions and extreme temperature fluctuations.

**AUSTRALIA**  
*Port Bonython containment embankment*

Terre Armée designed and built the containment embankments for the Port Bonython propane and butane tanks near Stony Point, south Australia. The structures are up to 10.5 meters high and 75 meters in diameter. Their retention capacity is equal to the storage capacity of the tanks (some of which hold more than 100,000 cu. meters).



**PERU**  
*Cerro Verde mine*

Within the perimeter of the copper mine, which is located in Arequipa Province, the company designed 34 meter high Reinforced Earth® walls and also supplied the materials and provided technical support.

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Mines & Quarries

## Mines & Quarries

### WALLS COMMENSURATE WITH AMBITIOUS PROJECTS

Reinforced Earth® retaining walls and TechSpan® arches meet the requirements of mining structures, which must support heavy loads, withstand vibrations and absorb impact. Our range of facings enables our walls to adapt to the specific geometry of each structure (surface tilt, straight or curved alignment).





Dams & Reservoirs



### CHILE *Las Tórtolas Dam*

Terre Armée worked on the construction of a Reinforced Earth® impoundment dam in Las Tórtolas. Four walls were built with two successive heights (14 meters and 22 meters) over a length of 300 meters.

Scan this code to watch the video of this structure



## Dams & Reservoirs

### EXEMPLARY IMPOUNDMENT

The Terre Armée technique is used to raise dams and increase reservoir capacity. It optimises dam and embankment construction costs by reducing or eliminating slopes downstream from the structures. Terre Armée is also combined with a waterproofing system to build drinking water reservoirs. Terre Armée has also developed systems combining fully synthetic connections and reinforcements, which are particularly well suited to projects in which the backfill contains chemically corrosive materials.



Environment



### SPAIN *Cut-and-cover tunnel on the A23 motorway*

Following a landslide in the Pyrenees, emergency work was carried out to secure a section of the A23 motorway in the central Province of Huesca. Terre Armée designed, fabricated and installed a cut-and-cover structure to protect the motorway from rockfall. The 232 meter long structure is made up of precast walls, piers, lintels, pre-slabs and beams.



## Environmental Protection

### FLEXIBILITY FOR SAFETY

As a result of its high resilience and ductility, Reinforced Earth® is an ideal technique for the construction of structures designed to provide protection from natural hazards such as avalanches, landslides, rockfalls and tsunamis. Avalanche berms, slope stabilisation structures and breakwaters limit damage to people and the environment. The welded wire mesh facings used in the TerraTrel® and GeoTrel® systems offer greater flexibility and facilitate logistics and construction in hard-to-reach areas. TechSpan® arches and TechBox® boxes are used to cover road sections and protect them from rockfall and landslides.



Ports & Coastal sites



**CANADA**  
*Port Cartier*

Terre Armée designed the seawall in the city of Port Cartier, Quebec. The structure was built using Reinforced Earth® and concrete facings together with GeoStrap® reinforcements.

## Ports & Coastal sites

### A WELL-PROTECTED COASTLINE

The Reinforced Earth® technique is used to build port and coastal structures that can withstand marine environments, notably currents, floating debris, tidal waves and drifting ice. Reinforced Earth® panels are combined with appropriate backfill to ensure efficient drainage of marine structures. Lastly, the Reinforced Earth® technique is particularly well suited to the construction of retaining structures on narrow coastal strips of land where reclamation is necessary.



Railways



**UNITED KINGDOM**  
*Channel Tunnel Rail Link*

The CTRL high-speed line connects London with the Channel tunnel terminal in Folkestone. Terre Armée designed two cut-and-cover tunnels with lengths of 360 meters and 170 meters respectively using the TechSpan® precast concrete arch system.



## Railways

### DURABILITY ON TRACK

Very early on, Reinforced Earth® demonstrated its full potential in the railway sector for track and track supporting structures. The technique has many advantages including high resistance to static loads, vibrations and earthquakes. It uses materials with outstanding durability. It can be easily adapted to geotechnical and architectural specifications.

Reinforced Earth® structures can be built within a short amount of time, require a small land take and have a low environmental footprint. TechSpan® arches, for their part, are used to build railway tunnels under backfill and cut-and-cover structures. We provide solutions for all types of railway lines, including high-speed, regional transport, light rail and tram-train lines.



## **THE TERRE ARMÉE SPIRIT**

The people at Terre Armée share a passion for engineering, excellence in customer relations and an exacting safety culture.

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## OUR TEAMS

Guided by a strong team spirit, Terre Armée's employees around the world are committed to innovation and excellence.

### SHARED VALUES

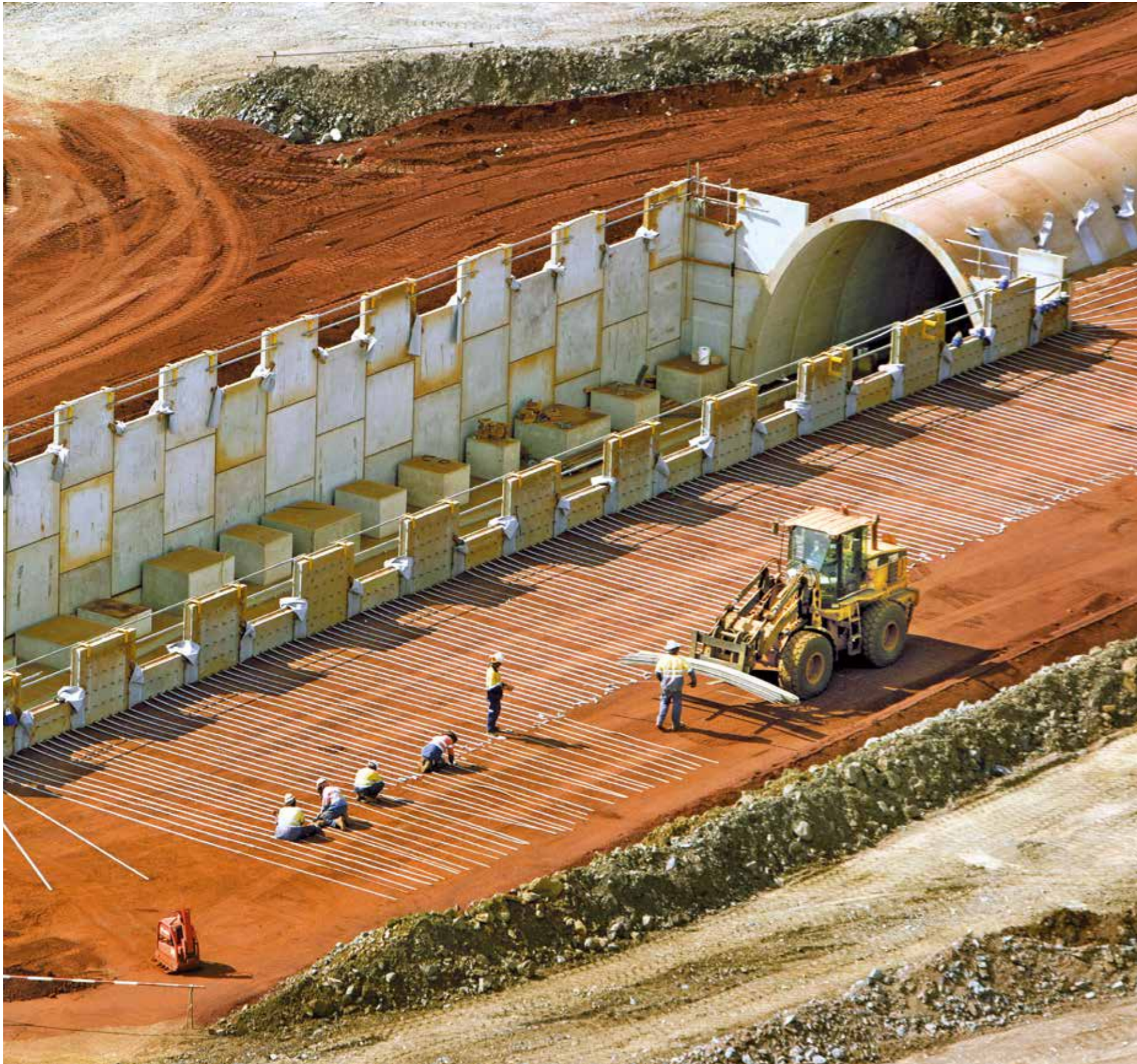
Within their respective geographical scopes, our subsidiaries use local talent. Spanning this geographical and cultural diversity, our employees share the same overarching values of safety, innovation, excellence and the commitment to more sustainable and environmental friendly ways of doing business. Safety is a strong part of Terre Armée employees' culture. Innovative capacity underpins the approach taken to each project by our design offices and is the hallmark of their pride in being part of Terre Armée. The quest for excellence guides our teams in their decision-making and their actions. Also, Terre Armée strives for Gender Equality, diversifying our supervisory staff to include more women.

### ENHANCING SKILLS

One of the Group's priorities is training the various categories of employees. We invest in our employees to foster their development and adapt to the changing needs of our clients. Training programmes support Terre Armée excellence goals and reinforce our community of experts.

### A COMMUNITY OF EXPERTS

The people at Terre Armée strive to design the best technical solutions for each project, optimise costs and lead times and rigorously comply with all commitments made to clients. Our community derives its strength from the fact that local experience is shared globally. The engineers and technicians in each design office thereby have the benefit of the experience gleaned by all Terre Armée subsidiaries. Our internal network of experts supports their specific needs.



## SAFETY

Terre Armée applies a rigorous safety policy across all its subsidiaries. The goal is Zero Accidents.

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### TRAINING AND AWARENESS

Keeping on strengthening the safety culture within the Terre Armée Group is key. We encourage our employees to integrate safety at every stage of our projects and within our plants. We painstakingly raise awareness and train our workforce so that they are proactively in accident prevention and safety.

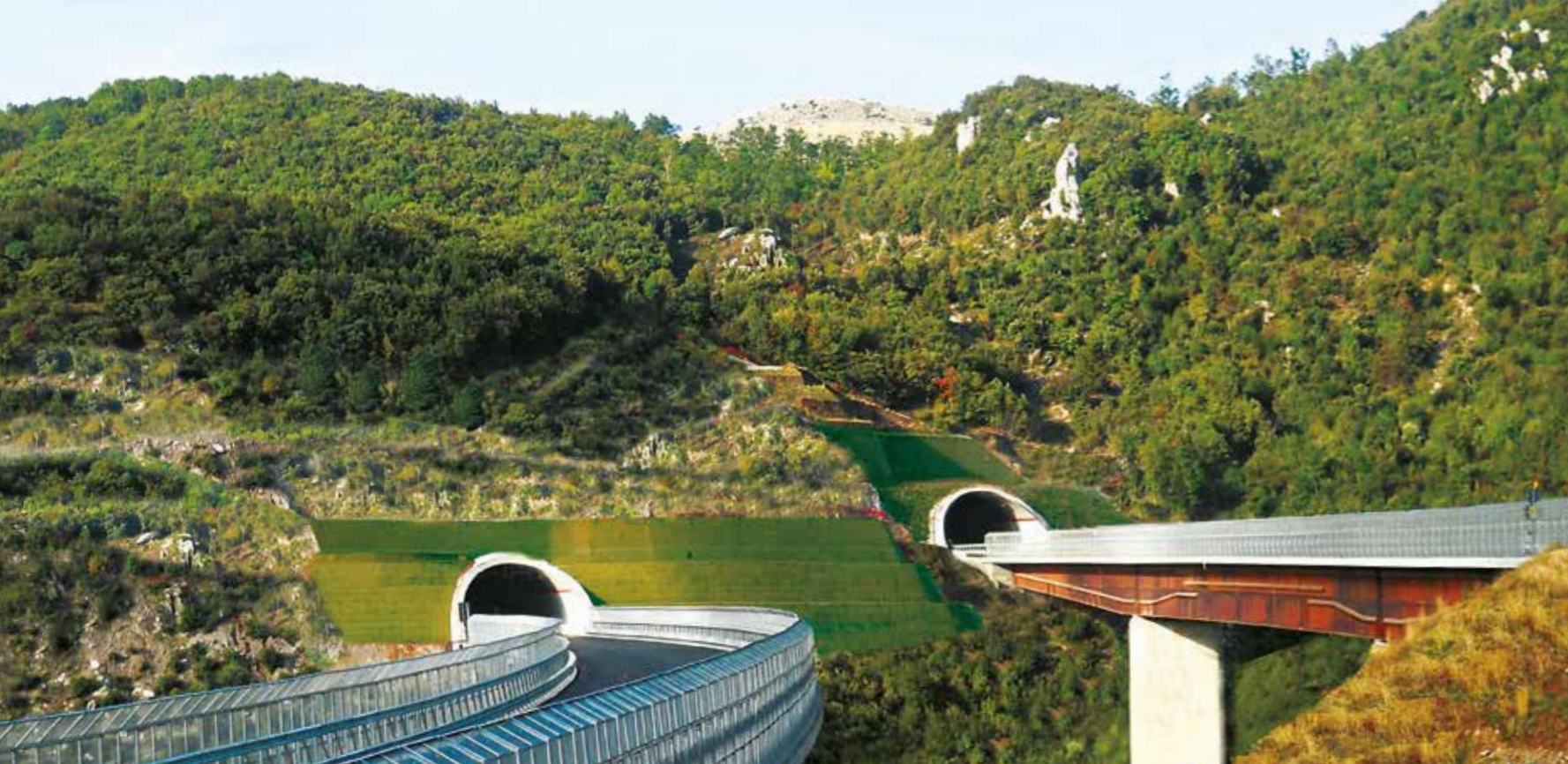
### MANAGERIAL COMMITMENTS AND LEADERSHIP

Managers at all levels are closely involved in safety. They set an example, ensure effective implementation of safety measures, notably by regularly visiting the worksite, and pay close attention to feedback from the teams in the field. Sharing our successes and best practices is fundamental at Terre Armée.

### REVIEW AND ANALYSIS OF ALL ACCIDENTS AND NEARMISSSES

Our safety culture is nurtured by the systematic in depth review of all kinds of incidents, especially those with a high potential for gravity. Sharing the root causes and corrective action plan helps avoid recurrence and improve safety. A debriefing is systematically planned with the company's senior management and shared among the group's entities for learning.





## ENVIRONMENT

Caring for our planet through concrete actions

### CONTROLLING ENVIRONMENTAL IMPACT

Our engineers design technical solutions requiring smaller volumes of materials (concrete, steel) than conventional construction methods and using materials with lower emission factors. These solutions, which range from Reinforced Earth® retaining systems to precast concrete TechSpan® arches, have a much smaller carbon footprint than cast-in-place reinforced concrete structures.

### LOW CARBON CONCRETE

Our R&D programs enable us to design increasingly efficient solutions that keep pace with environmental goals. Our innovation team has worked towards integrating low carbon concrete to manufacture our precast elements, therefore allowing for a direct reduction of carbon emissions and significant reduction of the carbon footprint of our solutions.

### OPTIMIZING RESOURCES THROUGH CIRCULAR ECONOMY

Our years of engineering experience have allowed us to develop a deep understanding of our structures' long term behavior and of our wide range of steel and geosynthetic reinforcements. One of the key elements is the introduction of recycled materials through circular economy processes. This goes from challenging how we design and produce, to reducing the use of extracted virgin raw materials.

### CARING FOR THE FAUNA, THE FLORA AND NATURAL RESOURCES

For many years, our solutions have been used as part of applications aiming to protect animals, preserve and foster natural environments, and help protect and manage natural resources like water. Our wildlife crossings, green solutions, and water management solutions are perfect examples.

### INFRASTRUCTURE DURABILITY AND SUSTAINABILITY

Our engineers pay special attention to durability, making our structures last as long as conventional structures but with a reduced carbon footprint. The inherent characteristics of our solutions make them resilient and resistant to the effect of time.

## WHERE TO FIND US

Terre Armée has locations in 50 countries to support you around the world.



### OUR PUBLICATIONS

Download our brochures and magazines at [www.terre-armee.com](http://www.terre-armee.com)



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**TERRE ARmee**

[www.terre-armee.com](http://www.terre-armee.com)