Major project

QUADRILATERO MARCHE-UMBRIA

P. 12 ITALY

2nd semester 2015 — N° 229

TERRE ARMÉE Magazine

TERRE ARMEE

THE IMAGE

GATEWAY WA, AUSTRALIA
Over 30,000 sq. metres of Reinforced Earth® walls

The major Gateway motorway infrastructure project in Western Australia is designed to improve the flow of traffic on one of the region's main road arteries. Following delivery of 1,775 sq. metres of facing panels for the Abernethy interchange in early 2013, The Reinforced Earth Company (RECo) Australia was awarded the contract to design and supply 25,900 sq. metres of TerraTilt® full-height facing panels, 820 sq. metres of modular TerraPlus® facing panels and about 2,000 sq. metres of TerraTrel® metal facing panels for the access road to the Perth airport and its freight zone. The teams had to innovate to adapt to the technical constraints of the worksite (structures located under the water table, complex finishing of some facing panels, etc.), and to build temporary walls to retain the backfill and keep adjacent roads open to traffic. The project got under way in 2013 and is scheduled for completion at the end of April 2015 with the handover of the last panels.

More about our airports applications.

The word

Nowadays, 50% of our population live in urban areas eand, according to the UN, this figure is likely to reach 70% in 40 years' time*. Indeed, in all countries around the world many cities are extending their city limits, planning new roads, tunnels and bridges and increasing the density of their public transport networks.
Against this backdrop, Terre Armée's know-how and expertise have been used to good effect in these major cities, such as in the creation of BRT lanes in Rio de Janeiro for the 2016 Olympic Games, in the construction of a rail and road viaduct in Krakow or in the involvement in a massive highway project in Orlando, Florida. The intrinsic characteristics of our Reinforced Earth®, TechSpan® and TerraLink™ techniques including their limited footprint, geometric flexibility, short construction time and minimal interruption to traffic during the construction period make these techniques the most appropriate choice for development schemes in urban areas.
For each project our teams work closely with architects and city planners to design custom solutions that meet the most exacting æsthetic and environmental constraints.
For over 50 years, Reinforced Earth® techniques have been deployed in the development of our cities and transportation infrastructure. Our goal is to continue to work with you and enhance our environments together.

ROGER BLOOMFIELD,
CEO OF TERRE ARMÉE

Contents

«Terre Armée Magazine» is the successor to «Soils and Structures», providing a twice-yearly overview of our projects worldwide. The magazine complements our web site www.terre-armee.com, which contains more news and information about our business.

Terre Armée Magazine, Terre Armée's twice-yearly magazine • **Communication Department:** 280 avenue Napoléon Bonaparte, 92500 Rueil-Malmaison, France • **Editorial manager:** Guillaume Billaroch • **Editors in Chief:** Nathalie Gresset and Tiphaine Guillot • **Contributors to this issue:** Juliette Dumoulin, Agnès Baranger, Anik Jean, Michele Curry, Isabelle Mennesson, Thomas Colombain and Anne-CécileGass • **Design:** [redacted] **Production:** EMAPRESS **Translation:** Telelingua • **ISSN:** pending • **Photo credits:** Soletanche Freyssinet Photo Library, Divulgacao – Prefeitura do Rio, Clément Ver Eecke,Panda Power Funds • **Contact:** mag@sf-group.com

34 metres

The figure

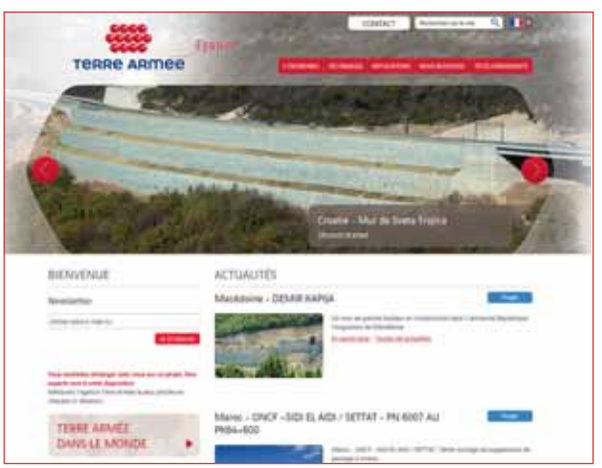
A new world record for the highest vertical GeoTrel® wall using synthetic reinforcement, constructed at the Cerro Verde mine in Arequipa, Peru.

The contract

USA – Largest Contract in RECo History.

In March, after several months of negotiation, The Reinforced Earth Company USA signed the largest contract in the history of the company – the I-4 Ultimate in Orlando, Florida. The 21-mile makeover will transform the region by adding two tolled travel lanes in each direction in the middle of I-4 along with improved intersections along the route. The project is a 3P (Public Private Partnership) with a Concession term that is 40 years and a 6 year construction duration. The project has an estimated 290,000 m^2 of Reinforced Earth® walls.

The country



France

Following on from Russia and Mexico, our French subsidiary is launching its dedicated website.
www.terre-armee.fr

The test

Full scale experimentation in France

Driven at a speed below 100 km/h, a 73cm metal sphere was launched against a Reinforced Earth® fill bund by IFSTTAR to simulate a rock fall. The impact energy of about 1000 kJ was impressively dissipated inside the soil mass without compromising the stability of the structure. This experimentation delivered results demonstrating the high performance of our structures.

The event

Brazil – Terra Armada is 40 years old

Founded in Rio de Janeiro in 1975, Terra Armada has completed over 800 projects with a total surface area of over one million m². Since the first wall built 40 years ago, Terra Armada continues to participate in large-scale undertakings such as the BRT Transolímpica project, a motorway undergoing construction in Rio de Janeiro as part of the preparations for the 2016 Olympic Games.

The next big thing

New brochures dedicated to the application of our technologies in the fields of Oil & Gas and Airports are available. Visit our website to find out more about the brochures and order a copy.

The technology

TerraLink™, Road widening in a confined urban environment

The challenges

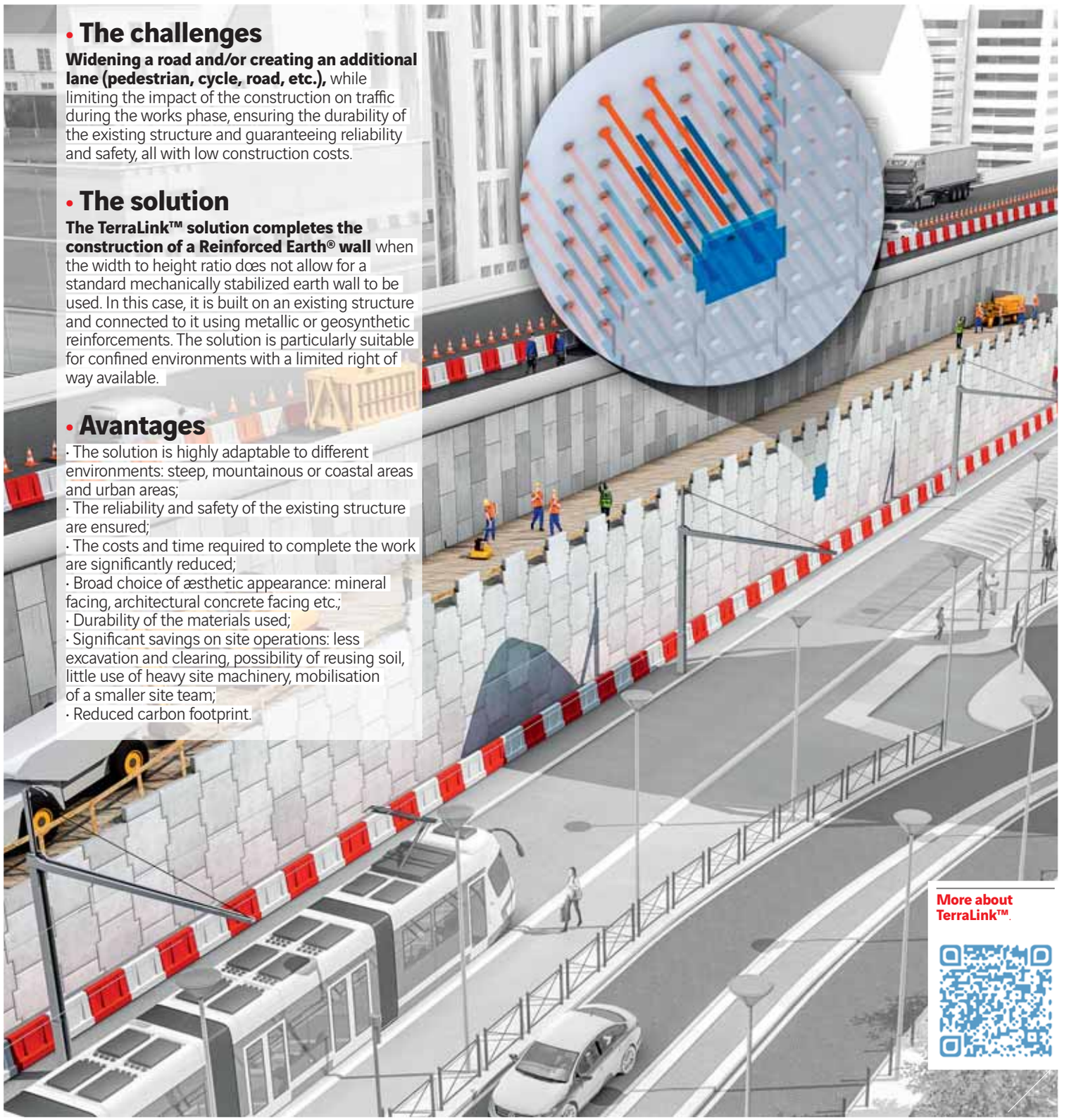
Widening a road and/or creating an additional lane (pedestrian, cycle, road, etc.), while limiting the impact of the construction on traffic during the works phase, ensuring the durability of the existing structure and guaranteeing reliability and safety, all with low construction costs.

The solution

The TerraLink™ solution completes the construction of a Reinforced Earth® wall when the width to height ratio does not allow for a standard mechanically stabilized earth wall to be used. In this case, it is built on an existing structure and connected to it using metallic or geosynthetic reinforcements. The solution is particularly suitable for confined environments with a limited right of way available.

Avantages

- The solution is highly adaptable to different environments: steep, mountainous or coastal areas and urban areas;
- The reliability and safety of the existing structure are ensured;
- The costs and time required to complete the work are significantly reduced;
- Broad choice of æsthetic appearance: mineral facing, architectural concrete facing etc.;
- Durability of the materials used;
- Significant savings on site operations: less excavation and clearing, possibility of reusing soil, little use of heavy site machinery, mobilisation of a smaller site team;
- Reduced carbon footprint.



More about TerraLink™.

AROUND THE WORLD

Peru
CERRO VERDE MINE

In order to support the significant increase in production at the Cerro Verde copper mine, Tierra Armada Perú has designed 34 metre-high walls for two primary crushers to facilitate maneuvers for dump trucks weighing approximately 700 tonnes. 4,400 m² of GeoTrel® Reinforced Earth® walls were erected with GeoStrap® reinforcements. Tierra Armada Perú also provided technical assistance and materials.

AROUND THE WORLD

Australia
CRAVENS CREEK CROSSING

Reinforced Earth Company Australia was awarded the design and supply of two Reinforced Earth® TechSpan® arch with TerraPlus® retaining walls as part of the East West Arterial Stage 2 Project. The arches have a length of 36m and a span of 18.3m. The project should be completed by late-2015.

United States
A NEW LEASE OF LIFE FOR THE ONE-HUNDRED YEAR OLD STATION IN DENVER, COLORADO

In order to transform the one-hundred year old train station into a multi-modal transport platform, The Reinforced Earth Company USA built welded mesh retaining walls for the bus terminal. RECo then designed the Reinforced Earth® walls for the platforms of the light rail transport network (LRT).

Chile
LAS CHILCAS ROAD

To improve safety, prevent car accidents and regulate traffic on an important artery in Chile, the Ministry of Public Works decided to increase the number of lanes and security standards. To do so, Tierra Armada was awarded the build-up of 5 permanent walls for a total of 10 535m² with a height of 18 meters.

Panama
REINFORCED EARTH® WALLS IN SAN ISIDRO

As part of the civil engineering works for the Panama Metro (Line 1), five TerraSquare® facing walls with high adherence steel reinforcements have been erected. They represent a total surface area of 4,866 m2 with a maximum height of 9.75 m. Tierra Armada de Panamá is responsible for the design, supply of materials, manufacturing and assembly of the panels.

Mexico
TECHBOX IN SALAMANCA

Part of the work to expand oil company PEMEX's refinery in Salamanca, two irrigation channels necessitated to be covered on 12 m and 18 m. To ensure the shortest lead time possible, Tierra Armada de México suggested using TechBox precast components as a cost-effective technical solution. Both structures have a 12 m span and a 4 m internal height. Construction took only 4 days per structure.

AROUND THE WORLD

Poland
RENOVATION OF A VIADUC IN KRAKOW

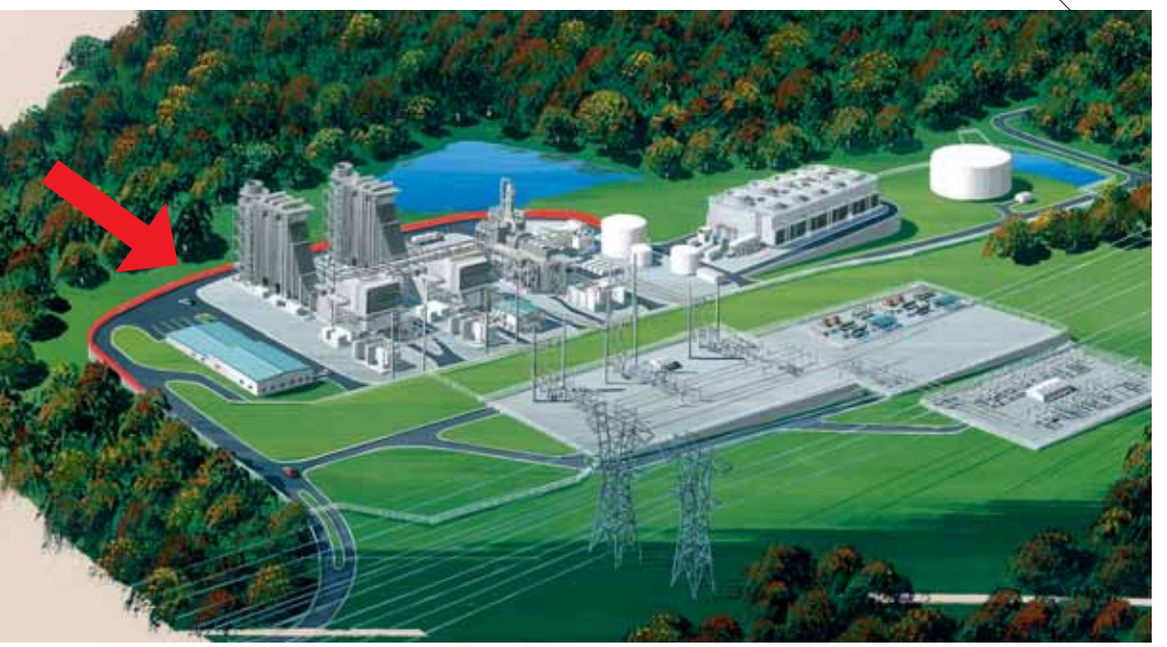
To rebuild an old railway viaduct passing over a stream and a street, the Terre Armée division of Freyssinet Polska designed and installed TechSpan® arches with a span of 14m and a maximum height of 3.6m and retaining structures made with TerraClass® and TerraTrel®. As the challenge was to ensure continuity of traffic, installation was carried out at night.

Netherlands
THE BEACH FOR EVERYONE

To increase its appeal, the city of the Hague has had their old coast road rebuilt. In order to facilitate access to the beach for the elderly and people with reduced mobility, Terre Armée BV has designed a ramp on the promenade made up of crushed concrete backfill and EcoStraps™.

South Korea
DOWNTOWN TUNNEL IN TECHSPAN®

The Terre Armée division of Freyssinet Korea has been awarded the Dogae-Bonglim project, a cut-and-cover double arch tunnel of 300m. They replaced the previous steel structure by TechSpan® arches in order to stop water leakages, large deformations or foundation cracks. The tunnel is made of 448 segments for a total width of 2.8m, a span of 10.1m and a rise of 5.8m.



United States
REINFORCED EARTH® FOR HYBRID ENERGIES

As part of the construction of a natural gas power station, The Reinforced Earth Company USA has designed a retaining wall with a height of 11.5 m at the edge of the property allowing a significant decrease in the footprint and therefore the volume of backfill. The project should be completed in spring 2017.

Serbia
REINFORCED EARTH® ACCESS RAMPS FOR EUROPA BRIDGE

Terre Armée France designed and supplied materials to achieve the construction of two access using ramps in Reinforced Earth® for the Bridge Europa in Novi Sad in June 2015. The ramps are made of TerraPlus® concrete panels with GeoStraps® strips for a total surface of 2150 m² and a maximum height of 7,7 m.

QUADRILATERO MARCHE-UMBRIA

Improvement of traffic flow in the Marche and Umbria regions by extending the road network.

The essentials

— The project: Road construction to improve the flow of traffic in the Marche and Umbria regions
— Terra Armata's assignment:
Phase 1 Design and supply of 1,500 linear metres of TechSpan® arches and technical support for their installation; design and supply of 20,000 m² of Reinforced Earth® retaining walls with TerraClass® panels
Phase 2 (In progress) design and supply of 750 linear metres of TechSpan® arches and technical support for their installation.
— Duration: 42 months

ITALY

A major road infrastructure project

The Quadrilatero Project is designed to improve the flow of traffic with the addition of 160 km of new roads, linking the Adriatic coast to the interior of the Marche and Umbria regions. This project is composed of two phases:
1. Foligno - Civitanova Marche (road SS77)
2. Perugia – Ancona (roads SS76 and SS318).

Terra Armata's involvement

Terra Armata worked on the SS77 motorway, a key infrastructure connecting Foligno and Tolentino. The company designed, in collaboration with Tierra Armada (Spain), and supplied 1,500 linear metres of TechSpan® arches and provided technical support for their installation. It also designed and supplied 20,000 m2 of Reinforced Earth® retaining walls with TerraClass® panels.

A constant concern for safety

Safety was a major concern on the site due to the poor weather conditions, seismic risks in the regions and the short deadline for the project. Terra Armata is currently participating in phase 2 of the Quadrilatero project: the construction of 750 linear metres of TechSpan® arches.

20,000 square metres
is the total surface area of the Reinforced Earth® retaining walls designed and supplied by Terra Armata for the second phase.

2,250 linear metres
Is the length of the TechSpan arches designed and supplied by Terra Armata for the two phases.

The partners

— Client: Quadrilatero Marche – Umbria S.P.A. (Anas)
— Design:
Phase 1 : A.T.I. Technital-Egis-Soil-Sics-Sis
Phase 2 : Sgai
— Prime contractor:
Phase 1 : Val di Chienti (SEP Strabag-CMC-GLF)
Phase 2 : Dirpa (SEP Operae-Toto-Ergon)
— Subcontractor:
Terra Armata S.r.l

MATTEO RIVA ,
CEO OF TERRA ARMATA

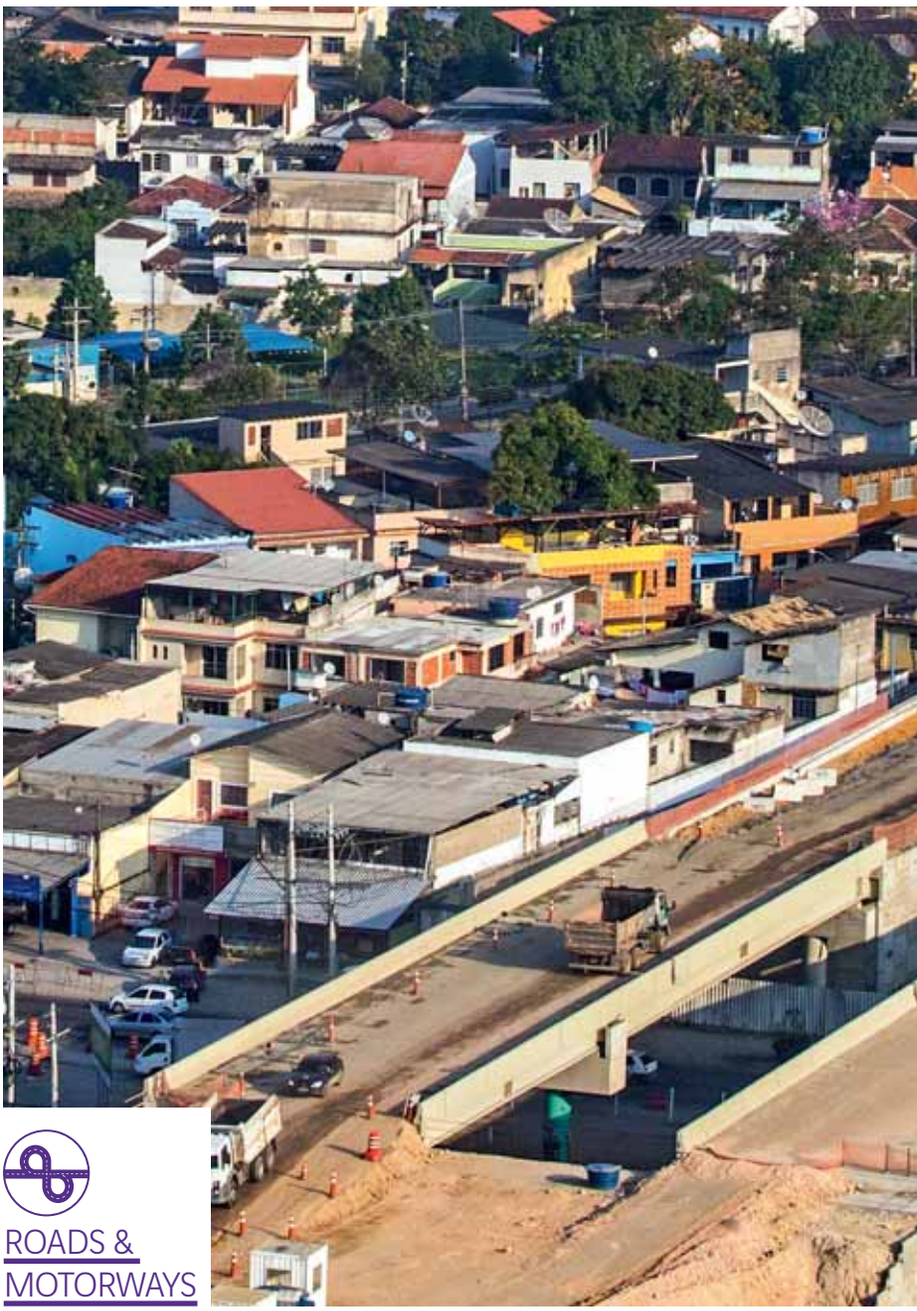
”The level of performance achieved on such a complex project and in such a critical environment has confirmed the prominent position of Terre Armée in its sector. ”

More about
TechSpan®.

16 APPLICATIONS

The techniques developed by the Terre Armée group are particularly suited to many market segments.
The various applications of our techniques are the following:

- Airports
- Dams & Reservoirs
- Energy
- Environmental
- Industry
- Land development & Building
- Military
- Mining & Minerals
- Oil & Gas
- Ports & Coastal works
- Railways
- Rivers & Waterways
- Roads & Motorways
- Sports & Leisure
- Waste management
- Water management



ROADS & MOTORWAYS

TERRA ARMADA: A MAJOR PLAYER IN THE UPCOMING RIO OLYMPICS!

Awarded the 2016 Olympics in 2009, the city of Rio de Janeiro needs to develop its public transport network in order to connect the four areas hosting the Olympic and Paralympic facilities. Terra Armada is taking part in this large-scale project.

© Divulgacao – Prefeitura do Rio

More about our techniques.

700 tonnes

Is the total weight of the high-adherence galvanised steel reinforcements used to reinforce the project's various structures.

50,000 square metres

Is the total surface area of TerraClass® walls built by Terra Armada.

Transolímpica
Aerial view of the Fontenelle express bus station.

Planning projects for 31st Olympic Games

The Transolímpica bus rapid transit line is part of a major public transport development project that will leave a significant legacy for Rio de Janeiro after the Olympic Games. It will cross the city from North to South and connect several competition sites, including the Olympic Park and the Athletes' Village in the Barra da Tijuca district and the X-Park in Deodoro. Started in 2012, the work should be completed by June 2016.

Terra Armada's involvement

Right from the start of the project in 2012, Terra Armada has been involved in the creation of the bus rapid transit lanes. Most of the Reinforced Earth® structures in this project were designed to support the access ramps for the road bridges. Some 50,000 m2 of walls with TerraClass® facing will be built by Terra Armada, with over 700 tonnes of high adherence galvanised steel reinforcements. Terra Armada is also responsible for the supply of materials and full-time technical assistance on site.

Sustainability of this urban axis

Once the Olympic Games come to a close, the new rapid transit line will remain as an important urban artery that will be used by 70,000 passengers and 50,000 vehicles per day, reducing traffic jams and, ultimately, improving quality of life. The dedicated lanes will be 26 km long with a total of 18 express bus stations and two tunnels, one of them passing through the Massif of Pedra Branca.

The essentials

— Works started July 2012
— Due for completion June 2016
— Extent 26 km - 18 express bus stations

The partners

— Client: Prefeitura do Rio de Janeiro
— Concession holder: ViaRio, S.A. (Invepar, Odebrecht Trasport and CCR)
— Prime contractor: Consórcio Transolímpica (Odebrecht and Andrade Gutierrez)
— Engineering: Sondotécnica and Serpen Engenharia
— Subcontractor: Terra Armada Ltda

ENVIRONMENTAL

ORIGINAL MATERIAL TO ENSURE THE PROTECTION OF THE UKKADAM BIG TANK, COIMBATORE, INDIA

As part of a renovation plan for several reservoirs, the Coimbatore municipality plans to build a peripheral road upstream of the reservoirs. As the stability of the banks was threatened by erosion, Reinforced Earth India was selected to design an erosion control system to maintain the structural integrity of the bund.

The main source of water supply

With the reservoir being the main source of water supply to the city, the water could not be drained to execute the protection works under dry or semi dry conditions.

The TechRevetment®

Reinforced Earth India put forward an alternative design using TechRevetment® – a concrete revetment mattress system that can be installed without the need to dewater. Reinforced Earth India's scope involved design, supply, training, developing methods of use and site assistance during the installation process.
In total, the work on the Tank required 10,000 m2 of TechRevetment®.

Maintaining balance

A layer of non-woven geotextile Hydrotex® was laid on the slope of the reservoir, then covered with filter fabric that eliminated the pore water pressure of the banks and contributed to maintaining a balance between the hydrostatic pressure differences in the event of fluctuations at the water's edge and retaining the head of water at the shore.

The essentials

— Bund height
7 m
— Bund width
7 to 10 m
— Thickness of erosion protection
102 mm
— Water depth
1.5 to 2 m
— Expected service life
+ 75 years

The partners

— Contracting authority: Municipal Corporation, COIMBATORE
— General contractor: KCP Engineering Pvt Ltd
— Design, supply and supervision of Erosion Control System: Reinforced Earth India Pvt. Ltd

10,000

Is the number of square metres of TechRevetment® designed by Reinforced Earth India to ensure the complete protection of the water reservoir against erosion.

JEFF BELZIUK,P. ENG. PROJECT SUPERVISOR AT VOLKER STEVIN, SPECIAL PROJECTS DIVISION

Reinforced Earth® walls to improve lake lifestyle

Reinforced Earth Canada was chosen to design and supply 12,600m² of TerraClass walls over a 6 year period at Mahogany Lake in Alberta, Canada. The project highlights include two sets of switchback stairs leading down to a submerged landing within the lake.

Terre Armée Magazine: What were the main challenges on this project?

Jeff Belziuk: Due to the sheer size of the project; staged and timely delivery of materials was key to the project's success.

T.A.M: What were the scope of work of Reinforced Earth Canada?

J.B: Reinforced Earth Canada not only supplied the nearly 10 000m² of panels for the Mahogany Lake Stage 2 Project but was also a valued partner in the design stage as their expertise contributed to an efficient constructible design that addressed the client's needs.

T.A.M: Did RECo Canada meet your expectations?

J.B: RECO's personnel and structure enabled them to quickly respond and deliver the solution to site with minimal to no delays on the project.

T.A.M: How would you describe your relationship with RECo Canada?

J.B: We have worked with RECo on several projects in the past and their continued ability to provide timely solutions to issues as they arise gives us the confidence and desire to work with them again on future projects.

Volker Stevin is one of the largest heavy civil and highway maintenance contractors in Western Canada, specializing in managing projects ranging from road construction and structural work to maintenance and asphalt/aggregate production. Volker Stevin has also been involved in canal works, light rail transit projects, the installation of irrigation systems, thermal district heating systems and conduit as well as various other highly specialized projects.

The essentials

— Located in Alberta, Mahogany Lake is the largest freshwater lake in Calgary with a total area of 63 acres
— Total surface 12 613m²
— Total length 2 828m
— Maximum height 8.5m

The year

More about TechSpan®.

1989

The launch of TechSpan® arches

25 years ago, Terre Armée developed TechSpan®, a precast concrete arch system. This technology, based on the Group's soil-structure interaction knowledge, enabled the development of the precast reinforced concrete half-sections. In 1998, TechSpan® was approved by the United States Department of Defense as a protective structure for munitions storage.

Around the world...

...In Germany

On the night of 9 November 1989, the fall of the Berlin Wall unified East and West after 28 years of separation. It sounded the ending of the Cold War and the start of a new chapter in German history.

...In the United States

On 17 December 1989, a particularly zany family was making its début on the small screen. The Simpsons was a resounding and ongoing success, as the series is still in production.
On a side note, the yellow colour of the characters is due to a blunder in the colour scheme when first broadcast!

SOLETANCHE FREYSSINET

The Soletanche Freyssinet Group, the global leader in the soil, structural engineering and nuclear sectors, brings together an unrivalled set of skills in the specialist civil engineering industry. In almost one hundred countries, its 21,500 employees offer clients their ability to design and implement solutions that meet the specific requirements of each project, however large or complex.

21,500 employees **80** countries **5** companies

FREYSSINET

A TECHNICAL CHALLENGE IN THE HEART OF LONDON

Renovation work on the Hammersmith Flyover is completed: after an initial phase of works completed in 2012, this second phase of works to strengthen the structure had commenced in January 2014 and included replacing the existing prestressing system, in partnership with the main contractor.

NUVIA

PRESTRESSING THE JULES HOROWITZ REACTOR

Having completed the seismic isolation of the nuclear unit, NUVIA is finalising the prestressing of the Jules Horowitz Reactor at the CEA site in Cadarache. The reactor is experimental in more ways than one with its innovative construction technology - prestressing with sheathed, greased strands and seismic isolation - which allows the achievement of the highest possible safety levels.

menard

GROUND IMPROVEMENT UNDER THE NEW PERTH STADIUM

Menard Bachy, in joint venture with GFWA, carried-out ground improvement to the leisure centre encircling the new Perth stadium in Australia. The works consisted in the installation of 2,700 m² of sheet piling, the ground improvement of 20,133 m² using dynamic compaction and the design and construction of controlled modulus columns to 49,000 m² of the site.

SOLETANCHE BACHY

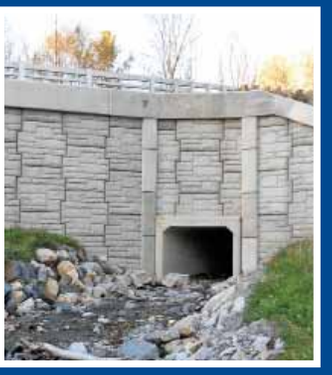
MALAYSIA: MEGA-MALL

A new mega-mall is set to rise from the ground in the centre of Kuala Lumpur, Malaysia. It will contain an Ikea store and the MyTown shopping centre. Bachy Soletanche Group Construction Malaysia, the local Soletanche Bachy subsidiary, has successfully completed the earthworks, special works and some of the civil engineering.

REINFORCED EARTH®

The Reinforced Earth Company's experienced team of professionals offers assistance at every stage of the project: conception, design, and construction. Each project is treated individually, combining innovation with technical expertise gained through proven performance. Above all, RECo's reputation for finding solutions to complex engineering problems, and our high level of customer service, is renowned throughout the world.

THE VALUE of EXPERIENCE



MSE Retaining Walls • Precast Arches • Noise Barriers

www.reinforcedearth.com