

Major project

REINFORCED EARTH® WALLS FOR THE CONCORDIA BRIDGE

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TERRE ARMÉE Magazine

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THE IMAGE



FRANCE First tests on the new SEA high-speed rail line

During tests carried out this summer on the new South Europe Atlantic (SEA) high-speed rail line (HSL) between Tours and Bordeaux, the test speed was increased to 352 km/h on one of the Reinforced Earth® structures supporting a track designed for a commercial speed of 320 km/h. Trains are set to begin operating on the line in 2017.



More about
the SEA HSL.





The word

RETAIN

CROSS

PROTECT

but also...

Structures and infrastructure are an omnipresent feature of our everyday environment and everyday life. Wherever we are, however we travel, we retain a memory of the setting and the surrounding landscape.

Today these structures transcend their primary purpose and as users we expect them to do more – to blend with their environment, be it urban or mountainous. This is why our design offices around the world not only focus on the structure’s ability to **RETAIN**, **CROSS** or **PROTECT** but also strive to serve the public by making the landscape the key part of the project and designing the structure around it.

In every one of our many projects, the challenge is therefore both technical and environmental. Examples are **reinforced embankments** faced with vegetation (page 6), the **Herb Gray Parkway** in Canada (pages 12 & 13), the **Cheras project in Malaysia** (page 16), and many other projects that are presented in our publications.

Like all our techniques, Reinforced Earth® lends itself to a wide variety of architectural options. Our teams work to devise construction solutions that combine operational excellence and beauty.



ROGER BLOOMFIELD,
CEO OF TERRE ARMÉE



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Terre Armée Magazine provides a biannual overview of our projects worldwide. The magazine complements our www.terre-armee.com website, which presents more news and information about our business activities.

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03



The contract

The I-15 interchange is the busiest stretch of highway in Nevada with 300,000 vehicles daily, or one-tenth of the state’s population. Traffic through the corridor is expected to double by 2035. In June 2016, as part of the NEON project of 6 km extension of the I-15 interchange, the largest public works project in Nevada’s history, The Reinforced Earth Company USA was awarded a contract for the design and supply of 20 Reinforced Earth® walls totaling nearly 800,000 square feet. The Reinforced Earth Company portion is to run approximately three years.

The event

GeoVancouver, Canada

From 2 to 5 October 2016, The Reinforced Earth Company, a Terre Armée entity in Canada, sponsored and took part in the 69th Canadian Geotechnical Conference, GeoVancouver 2016. The key event, organized by the Canadian Geotechnical Society in partnership with the Vancouver Geotechnical Society, brings major geotechnical industry stakeholders – academic researchers, consultants, general contractors and suppliers – together to discuss their results and the latest innovations and technologies. This year the theme of the conference was “History and Innovation”.





The initiative

Fostering rational use of water and energy resources

At its prefabrication plant and on one of its worksites, Tierra Armada de Chile is carrying out an environmental campaign designed to raise awareness of energy issues and the need to foster rational use of water and electricity. Chilean customers commend the initiative.

The country

India

To celebrate the tenth anniversary of Reinforced Earth India joining Terre Armée, events were held in all its offices, plants and worksites. Meanwhile, Reinforced Earth India also held an event at the French Embassy in India to which its customers were invited.



The next big thing



Reinforced Earth® walls can be designed to suit your projects. Reinforced Earth® structures offer unlimited aesthetic and architectural possibilities. Examples of our projects are showcased in our 24-page brochure.



Order our brochures on line.

Transportation & Urban Mobility have become a central concern and a major focus of urban development. Our brochure presents a broad range of Terre Armée solutions that directly address these issues.





The technology

Reinforced embankments faced with rock or vegetation to blend with the landscape

• The challenges

Customers, project managers and urban planners are increasingly including **steep embankments faced with vegetation in their projects to cope with space limitations and blend the structure with the landscape.** These structures require a comprehensive engineering solution to ensure their appearance, mechanical strength and sustainability.

• The solution

Embankments faced with rock or vegetation blend seamlessly with the landscape in urban, suburban and mountainous settings. To build structures with 45° to 75° slopes, Terre Armée offers TerraTrel™ and GeoTrel™ solutions designed by our geotechnical experts.

• Advantages

- Experience/expertise: our design offices can design very steep embankments (up to 75°). Terre Armée has a wide variety of very high embankment project references (20 meter inclined length) around the world.
- Portable elements (suitable for remote areas)
- Aesthetics: seamless landscape blending and customizable geometry
- Economic benefits: lightweight elements for easy transportation and assembly (no lifting machinery required), rapid construction, low maintenance

• Numerous applications

- Retaining walls faced with vegetation
- Access ramps
- Hard surfaces
- Avalanche barriers
- Slope stabilization
- Rockfall protection
- Sports facilities (climbing walls)
- Noise barriers



AROUND THE WORLD



Bulgaria

DUAL SUCCESS FOR TERRE ARMÉE IN SOFIA

In 2015, the main civil engineering project in the Bulgarian capital, was the upgrade of the Sofia Northern Speed Tangent connecting the HEMUS motorway (serving the northeastern port of Varna) and the STRUMA motorway serving the southwest.

The lead contractor awarded the contract to Terre Armée France to design and supply the access ramps and bridge abutments for seven structures with a total of 20,000 m² of facings. The solution used TerraPlus® concrete facings and EcoStrap® reinforcements. The tight deadline – a major project requirement – was met. In the wake of this major project reference in Bulgaria, Terre Armée won the contract to design and supply Reinforced Earth® walls for the western bypass in Sofia. This additional project covers nearly 15,000 m² of facings (TerraTrel™ panels, which can be covered in vegetation, and TerraPlus concrete panels).



D. BRANCAZ

SALES ENGINEER, TERRE ARMÉE FRANCE

“The Sofia project owes its success first and foremost to the responsiveness of our teams. The success of the Northern Speed Tangent project led to the signing of a further another contract covering work on the bypass. The effectiveness and adaptability of the Terre Armée solution met the needs of the contractors. EcoStrap™ reinforcements enabled them to use recycled aggregate and the GeoTrel™ solution, which can be faced with vegetation, was suitable for all the western bypass retaining structures.”

RETAIN



United Kingdom BEAUTY AND SAFETY

The A465 major roadway upgrade in southern Wales is vital for the regional economy. The widening project will provide greater visibility and make passing safer. Reinforced Earth UK will be building several structures along this road, and more particularly sections of an uninterrupted 2 km retaining wall along a river in a deep valley. The retaining wall, built in conjunction with Knight Architects*, takes inspiration from the geological features of the landscape. The horizontal pattern reflects light differently when viewed from a variety of levels and at different speeds. The project called for the construction of a wall in panel layers similar to brickwork. The project demonstrates RECo UK's ability to meet the expectations of the various project stakeholders.

* firm specializing in infrastructure

©KnightsArchitects

CROSS



CROSS



Australia SNEYDES ROAD INTERCHANGE

In Australia, the Sneydes Road Interchange project will transform access to the East Werribee Employment Precinct by creating vital links with the M1 Freeway and the Princes Freeway in Victoria. Reinforced Earth Australia provided Reinforced Earth® abutments (1,025 m²) and precast concrete safety barriers for the new five-span bridge across the Princes Freeway. The TerraPlus® concrete facing panels used in the abutments were made with a Reckl® Lanzarote texture and painted finish. The Sneydes Road Interchange bridge was officially opened in late May 2016.



Poland FOUR TECHSPAN® TUNNELS AND FREYSSISOL® WALLS FOR THE S-19 EXPRESSWAY

The more than 570 km S-19 Expressway will cross Poland north to south through four voivodeships (provinces). Along the new 6 km section between the southeastern cities of Swilcza and Kielanówka, which has nine engineered structures, Freyssinet Polska is building four wildlife crossings using TechSpan® arches. These crossings, with a combined length of 160 meters, are equipped with 1,330 m² of Freyssisol® retaining walls. The structures are designed to prevent collisions between vehicles and wildlife crossing the expressway along their natural migration route.



Italy

REINFORCED EARTH® GEOTREL™ AND TECHSPAN® – A WINNING COMBINATION

As part of the major Salerno-Reggio Calabria expressway widening project in southern Italy, Terra Armata won the contract to supply materials and technical assistance for the construction of 4,500 m² of Reinforced Earth® walls using TerraClass/Cruciform® facing panels and 21,000 m² of inclined GeoTrel™ walls. The tight schedule – the main challenge of the project – was met thanks to rigorous weekly monitoring. The GeoTrel™ structures were erected in seven months and the Reinforced Earth® walls in five months. This success led to additional contract covering 2,000 m² of GeoTrel™ walls and nearly 100 meters of TechSpan® structures.

CROSS



CROSS



RETAIN



Panama

FIRST GEOSTRAP® WALLS IN PANAMA

On the Pan-American Highway extension project in Panama, the general contractor responsible for building several bridges and the roadway awarded the contract to Tierra Armada de Panamá covering design, supply and technical assistance for the country's first walls equipped with GeoStrap® geosynthetic reinforcements and GeoCore® connectors. These will be built along the entrance and exit ramps to and from the bridges over the Chorcha and Chiriquí Rivers in Chiriquí province.



Germany

EXTENSION OF THE B62N HIGHWAY IN SIEGEN



As part of the B62N road extension work in Siegen, North Rhine-Westphalia, Bewehrte Erde (Terre Armée's German entity) designed, supplied and installed three Reinforced Earth® retaining walls with cruciform TerraClass/Cruciform® precast concrete panels equipped with high-adherence galvanized steel reinforcing strips between two bridges. Overall, nearly 2,200 m² of Reinforced Earth® walls with a maximum height of 11 meters were built alongside a railway track. In another project in Siegen, the first phase of work on a tiered wall was completed. The TerraTrel™ system with high-adherence galvanized steel reinforcement was used on this project.



RETAIN



Vietnam DA NANG-QUANG NGAI EXPRESSWAY

In central Vietnam, work on the Da Nang-Quang Ngai expressway is designed to improve traffic safety and facilitate travel between Da Nang city and Quang Ngai province. Reinforced Earth Vietnam was selected to design and supply a Reinforced Earth® solution with TerraClass/Cruciform® facing panels and high-adherence steel reinforcement. The resulting wall has a surface area of nearly 6,700 m² and a maximum height of 12 meters. Reinforced Earth Vietnam also provided technical support for the work, which got underway in early 2016 and was completed in August.

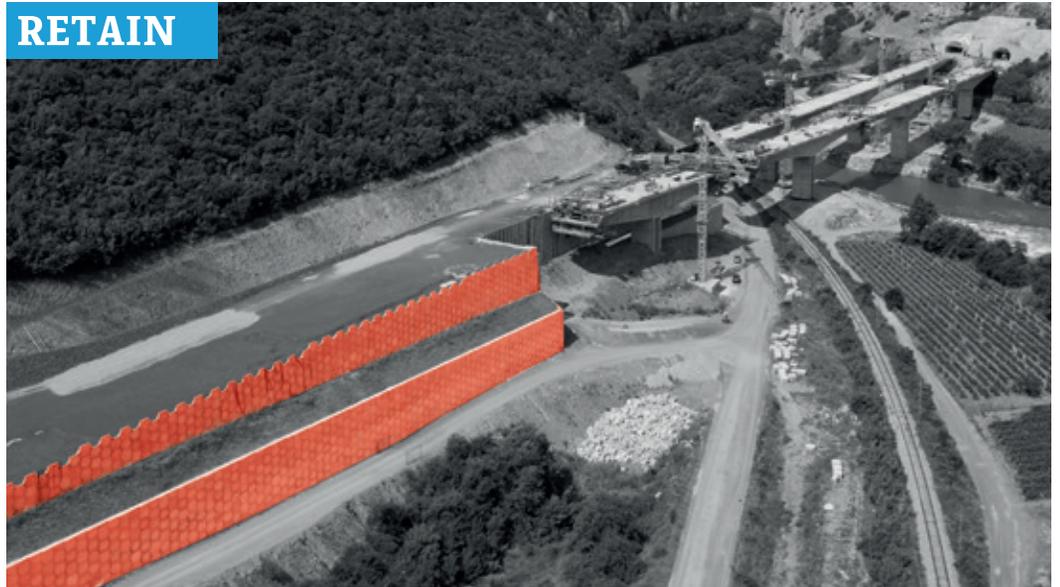
RETAIN



Macedonia RETAINING STRUCTURES UP TO 25 METERS HIGH

In southern Macedonia, where work is being carried out to build a section of the E75 expressway connecting the cities of Demir Kapija and Smokvica,

Terre Armée replaced the spans of a viaduct. The construction teams designed Reinforced Earth® walls with TerraClass/Cruciform® panels and GeoStrap® reinforcements. The walls are up to 25 meters high and cover a total surface area of 7,100 m².



CROSS



South Africa REINFORCED EARTH®, TERRATREL™ AND TERRACLASS® - OUR THREE SOLUTIONS IMPROVE THE N7.

National route N7, an economically vital artery linking the Western and Northern Cape provinces in South Africa, is undergoing one of the country's largest infrastructure upgrades in recent years. The highway is being widened to four lanes and interchanges and long road sections are being built. Reinforced Earth South Africa (RESA) supplied 12 TerraClass/Cruciform® bridge abutments and two Reinforced Earth® walls (5,350 m², maximum height 7 meters). Temporary TerraTrel™ walls were also built to meet jobsite needs. The work got under way in 2012 with the Melkbosstrand bridge abutments and is scheduled for completion in late 2018.



CROSS



Chile

NEARLY 16,000 M² OF TERRACLASS® WALLS FOR THE CONCEPCIÓN CABRERO EXPRESSWAY

In the Biobío region 500 km south of Santiago de Chile, Tierra Armada Chile installed nearly 16,000 m² of TerraClass/ Cruciform® walls as part of the Autopista Concepción-Cabrero project. The Enlace Palomares intersection – one of 19 – has four Reinforced Earth® bridge abutments. Both our reinforcement families were used: geosynthetic strips for the wing walls and galvanized steel reinforcements for the part supporting loads generated by the bridge.

CROSS



CROSS



Venezuela

REINFORCED ACCESS ROADS FOR THE PIAR NATIONAL STEELWORKS

Tierra Armada de Venezuela designed and supplied Reinforced Earth® structures and TechSpan® arches for the rail and road connections to the Piar national steelworks in northeastern Bolívar State. Nine bridge abutments and four retaining walls using nearly 11,000 m² of TerraClass/Cruciform® panels with high-adherence steel reinforcements were built. TechSpan® arches with a total length of 130 meters were used to build four overpasses.



Mexico

REINFORCED EARTH® WALLS FOR THE CONCORDIA BRIDGE

In southeastern Mexico's earthquake-prone Chiapas region, Tierra Armada de Mexico is helping build the abutment for a cable-stayed bridge. The first phase of the work is nearing completion. The wall, which will eventually reach a total height of 26 meters, is shown above at its current height of 21 meters.



Major project

HERB GRAY PARKWAY

OVER 70 STRUCTURES AND 38,000 M²
OF REINFORCED EARTH®

The essentials

Reinforced Earth Canada was involved in Ontario's largest Public Private Partnership project of the past five years: the Rt. Hon. Herb Gray Parkway, named for a local politician. The project won the Environmental Achievement award presented by the Transportation Association of Canada.
— **Duration of work:** 5 years
Start of work: 2010
Completion: 2015



CANADA

An unprecedented undertaking

The major Rt. Hon. Herb Gray Parkway road infrastructure project in Ontario runs through the towns of Windsor, LaSalle and Tecumseh. The huge (\$1.4 billion) project will improve traffic flow on this major trade gateway between Canada and the United States as part of an international plan that includes an 11 km green corridor, new customs inspection points on either side of the border, work on the Gordie Howe international bridge and an interchange on the U.S. side that will link the cities of Windsor and Detroit by connecting Canada's Highway 401 with Interstate I-375 in the U.S.

Priority focus on urban communities and the environment

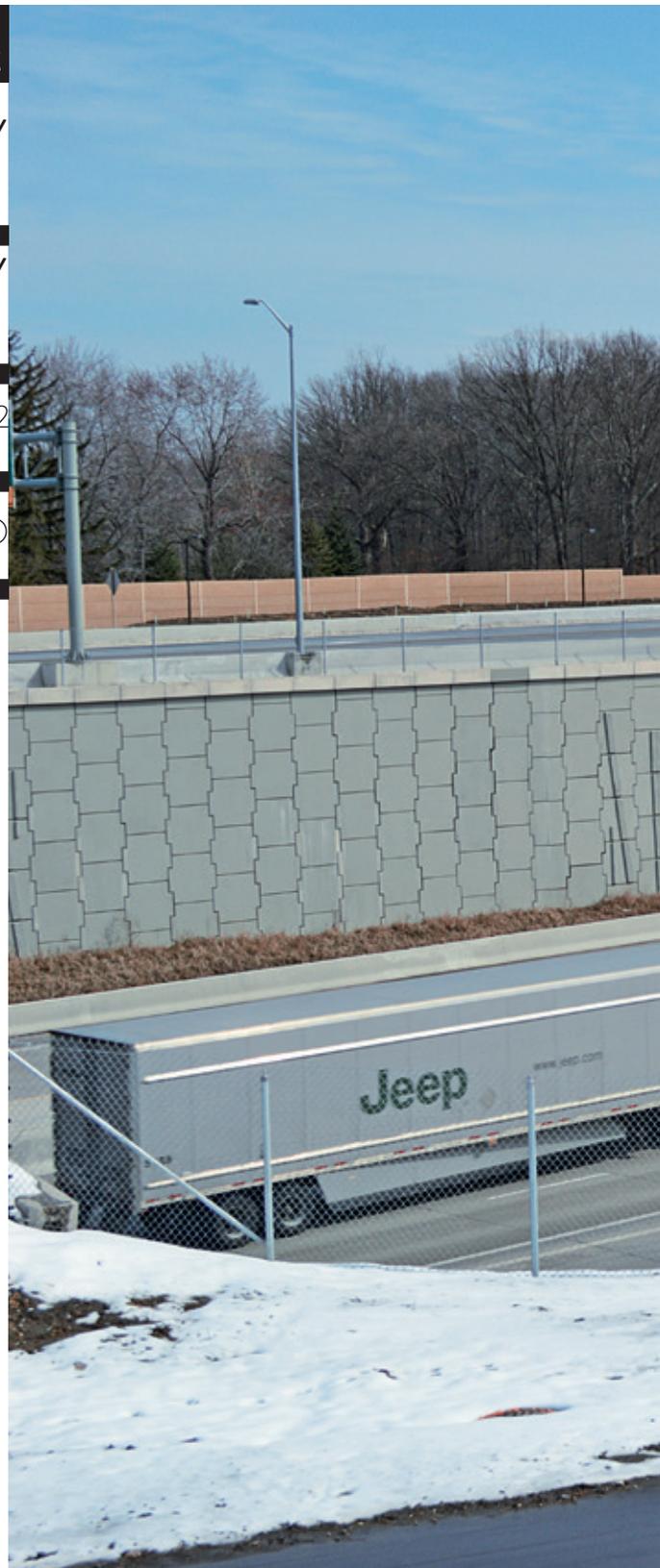
Designed to serve drivers and local communities, the road will support safe transportation of people, goods and services. Reinforced Earth Company Ltd. was responsible for designing and supplying retaining walls for more than 71 structures along the green highway. To mitigate disruption by limiting traffic in the section running through residential areas of Windsor, the highway was built entirely below grade

and more than 12 large overpasses (tunnels) were built to ensure the continuity of existing roads. A large number of green spaces and walking trails have been included along the heavily trafficked expressway.

Over **70**
Terre Armée
structures

Nearly **19,000**
facing pañels

Nearly **38,000**
square méters
of total surface area



The partners

- **Customer** Windsor Essex Mobility Group (WEMG) – Consortium ACS Infrastructure Canada Inc, Acciona Concessions Canada, and Fluor Canada Ltd.
- **Project manager** Parkway Infrastructure Constructors (PIC) – Joint Venture of Fluor Canada Ltd, Dragados Canada Inc and Acciona Infraestructuras Canada Inc.
- **Specialized contractor** Reinforced Earth Company Ltd.



Detail of an architectural TerraClass/ Cruciform® panel



DANIEL CALATRAVA,
REGIONAL MANAGER (CENTRAL), REINFORCED EARTH COMPANY LTD.

“On this project, Reinforced Earth rose to a large number of challenges. To address the poor quality of the foundation soils, we proposed cellular concrete as fill. We drew up an accelerated construction schedule and all our employees took part in a half-day program designed to raise their awareness of the region’s environment. The work therefore went smoothly and the regional environment – a threatened ecosystem with protected indigenous species (including birds, reptiles and snakes) – was protected.”

More about
Our Roads & Motorways
applications.





Applications

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

PROTECT



PROTECTING A ROAD FROM ROCKFALL

In Spain, the A-23 expressway, also known as the Autovía Mudéjar, connects the Mediterranean coast with the central Pyrenees. Shortly after it was opened, the major artery had to be closed due to a landslide blocking the roadway. Tierra Armada won the contract to secure the area against rockfall by offering a reliable solution that could be installed within a very short period of time.



100
precast
walls
with a height of 6.75 meters
almost
3,000
square meters
of precast pre-slabs
4 month
of work

Installation of protective walls on a mountainside.

A natural geological phenomenon

Rockfall occurs naturally. Rapid, discontinuous and sudden rock movements driven by gravity affect rigid and fractured materials such as limestone and crystalline sandstone, which can tilt, collapse or slide from cliffs or steep slopes.

Emergency work on a busy expressway

Following a landslide onto one of its roadways, the Spanish Ministry of Public Works issued a call for tender covering emergency work on the Nueno-Congosto del Isuela section in Huesca province. The project was designed to protect an area adjacent to the major highway from rockfall.

The vital safety work in the high-risk area included in building a 232-meter cut-and-cover structure using precast sidewalls, piers, lintels and pre-slabs.

A comprehensive rockfall protection solution

Tierra Armada designed, produced and installed the precast elements in a period of four months.

The essentials

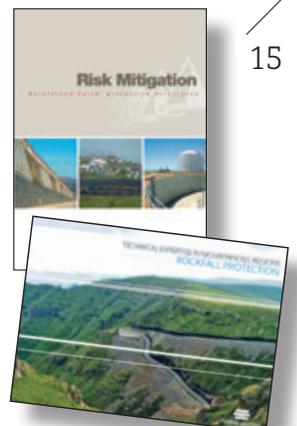
In the Pyrenees, Tierra Armada secured an area affected by a landslide.

- **Start of work** October 2012
- **Completion** February 2014

The partners

- **Client** Ministerio de Fomento. Demarcacion de Carreteras
- **Project Manager** Copisa-Arian-EASA-Ceinsa Joint Venture
- **Specialized contractor** Tierra Armada

Order our **Risk Mitigation and Rockfall Protection** brochures on the website



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CONSOLIDATION OF A WALL IN A RESIDENTIAL NEIGHBOURHOOD ON THE OUTSKIRTS OF KUALA LUMPUR



In a prosperous neighborhood on the outskirts of Kuala Lumpur, Malaysia, a retaining wall had been built in 2005 to support a property to be used for residential construction.

The concrete wall had begun to show signs of swelling and deformation and in early 2015 part of the wall collapsed. Temporary bracing was installed to prevent further damage while a permanent solution was sought.

An innovative solution using few materials

Reinforced Earth Malaysia proposed the innovative solution that ultimately solved the problem: a Reinforced Earth® wall on two levels with a maximum height of 12 meters, built in front of the existing structure to buttress and stabilize it.

Stability, simplicity, and rapid installation

The composite and flexible Reinforced Earth® wall efficiently and effectively supports the existing structure. It took less than five months to complete and was delivered more than a month ahead of schedule.

↗ The essentials

- **Duration of work**
5 months
- **TerraClass/ Cruciform®**
Nearly 5,000 m² and 2,500 panels
- **Height**
12 meters
- **Length**
40 meters



PATRICIO CAMACHO IVES, MANAGING DIRECTOR, AGUA SANTA S.A.



Read the full interview on the website: www.terre-armée.com



Agua Santa S.A. is a Chilean construction company founded 24 years ago. The company performs civil engineering work for both the public and the private sector and is currently working on a series of very ambitious mining projects.

Terre Armée Magazine talked with Patricio Camacho Ives, Managing Director of Agua Santa S.A.

Terre Armée Magazine: How long have you been working with Tierra Armada?

Patricio Camacho Ives: I have known about the Reinforced Earth® technique for 18 years (since 1998), but I carried out my first project with Tierra Armada in 2010 - the Las Tórtolas 1 mining project.

T.A.M: In what sectors have you worked with us?

P.C.I: Mining and road infrastructure.

T.A.M: Can the Terre Armée Group's techniques be applied in other areas covered by your company (for instance oil and gas tanks and risk mitigation)?

P.C.I: Certainly. My years of working with Tierra Armada have given me a clear picture of its versatile products and broad solutions. Our company is on the lookout for technical solutions that are both rapidly implemented and profitable and Reinforced Earth® is a highly effective, proven technique. The fact that all the projects

our two companies worked on together performed very well during the earthquakes of recent years gives us even greater confidence in Reinforced Earth® solutions.

T.A.M: Would you recommend us to your colleagues and advise them to include our solutions in other market segments?

P.C.I: Of course. In fact I am already doing that and we are currently recommending their use on a new road infrastructure project.

T.A.M: Could you list three advantages that give the Tierra Armada company a competitive edge?

P.C.I: Flexible solutions / Ongoing innovation / Customer relations.

T.A.M: What do you think best explains our success in working together?

P.C.I: The fact that our technical and commercial relationship is based on mutual trust.

Our projects with Agua Santa



Las Tórtolas 1



Las Tórtolas 2



Puente Maipo



 **The year**

More about
our Defense
applications

1998



Terre Armée joins the Freyssinet group and adds the Freyssisol[®] process, based on geosynthetic reinforcements, to its product range. The same year, the U.S. Department of Defense approves combined TechSpan[®] arches and Reinforced Earth[®] walls as the standard protection structure for ammunition storage depots.

This type of composite structure, which can absorb explosive energy, has since been installed at a large number of DoD sites.

Around the world...

...in Europe

The first Euro coin is minted.



...in the US

Céline Dion's "My Heart Will Go On" wins the Grammy Awards for Record of the Year and Song of the Year.



The Soletanche Freyssinet Group



SOLETANCHE FREYSSINET

Soletanche Freyssinet is the world leader in soil, structural and nuclear engineering. The Group brings together an unparalleled array of construction and engineering expertise and brands – Soletanche Bachy, Menard, Terre Armée, Freyssinet, Nuvia and Sixense – that provide technical excellence to boost the performance and durability of structures. Operating in about 100 countries with a workforce of 22,500 employees, the Group generated revenue of €3.2 billion in 2015.



22,500 employees 80 countries 6 companies



FREYSSINET



VAVUZ SULTAN SELIM BRIDGE – TURKEY

Freyssinet stay cables set a new world record.

The Yavuz Sultan Selim Bridge was officially opened in August 2016. The 1,408 meter hybrid bridge with Freyssinet cables set a new world record for cable-stayed span length.



NUVIA

STONES THAT REFLECT THE HISTORY OF SCIENCE

How are the reference materials that drive scientific progress conserved? They are kept in the underground vaults of the Ecole des Mines engineering school, as part of the City of Paris Museum collections. ANDRA*

entrusted to NUVIA the task of characterizing, sorting and packaging these fascinating, albeit radioactive, vestiges of history. The collection is one of a kind but precautions are required in its conservation. It includes “radioactive objects for medical use” that were employed in the first imaging tests and cancer treatments and gemstones (such as autunite and thorianite) used as reference materials and international measurement standards. NUVIA brings its full range of nuclear measurement expertise to bear in sorting and appropriately storing these rare treasures that played such an important part in the work of the international scientific community.

* The French national radioactive waste management agency



SIXENSE

THE NEW BRANCH OF THE SOLETANCHE FREYSSINET GROUP

In September 2016, the Soletanche Freyssinet Group launched its sixth branch: SIXENSE.

The new entity brings together 10 companies – some founded more than 20 years ago and others more recently – with a current combined workforce of 600 employees and operations in 20 countries. SIXENSE specializes in digital services and solutions for structures, soils and the environment. It is structured in three areas of expertise: Engineering, Digital and Technologies. To help its customers manage their construction projects, assets and risks, SIXENSE provides services including acquiring full familiarity with structures; managing processes and data; controlling risks; reducing costs and lead times; improving the structure’s life cycle; and overseeing construction. SIXENSE gives customers the services and tools they need to optimize design, understand structural behavior and support decision making throughout the infrastructure life cycle.



SOLETANCHE BACHY



INSURGENTES 700 TOWER IN MEXICO CITY

Cimesa, which has a substantial track record in high-rise construction in Mexico City, brings its full range of expertise and experience to the Insurgentes 700 project. Working in a particularly narrow construction site, Soletanche Bachy’s Mexican subsidiary is rising to the challenge of building deep foundations for a 15-storey office building. Following excavation, foundations consisting of 8,000 m² of diaphragm walls and 20 barettes were built to prepare construction of 16 levels of underground parking garages. The parking levels will be handed over at the end of 2017.



REFRIGERATED WAREHOUSE IN SWITZERLAND

Menard is expanding in Switzerland by working with Sif-Groutbor (a subsidiary of Soletanche Bachy), to consolidate the soil at the site of a new refrigerated warehouse to be built in Kölliken. The project must contend with two challenges: weather conditions that make it difficult to access the work area and local regulations that prohibit pouring concrete into the terrain. Following several investigations and additional testing, the SoilTeam proposed an alternative construction method involving the installation of stone columns over the 9,500 m² site. The work is scheduled for completion at the end of December 2016.

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RETAIN



REINFORCED EARTH

The Worldwide
Leader in
Reinforced Fills

Breaking records
with **GeoStrap™**
Reinforcements

CROSS



PROTECT

