



TERRE ARMÉE

Consistency and clarity within a comprehensive range of services

This is what convinced Carillion and Costain, the Reinforced Earth (UK) clients involved in the Welsh government's A465 Heads of the Valleys modernisation project. In order to increase traffic flow and improve driver safety, the teams worked to upgrade this key transportation route in the south of the country leading to a dual carriageway. Between Gilwern and Brynmawr (section 2), they built a 2km section of continuous retaining wall to support the new carriageway. The design, inspired by the area's geological characteristics, offers a different visual experience depending on the user; from motorists who will see the wall fleetingly to pedestrians who will have more time to inspect it in detail from afar. Section 3 of this project opened to traffic in 2016, which includes the highest (9.6 metre) TechSpan® arch ever built in the United Kingdom. Designed by Reinforced Earth (UK), with design checking done by Tierra Armada S.A. (Spain) and Terre Armée France, it involved a record height of backfill above the arch and the production of special arch units to make the installation of the structure easier and safer.

Three main business lines: Retain, Cross, Protect



ROGER BLOOMFIELD
Chief Executive Officer,
Terre Armée

2015 was a year of revival, how do you view the results of Terre Armée in 2016?

While the global economic context remained difficult, we continued our dynamic of revival and in fact accelerated it. The proof is in the Group's revenue and operating profit, which increased 18% and 30% respectively compared to the previous year. Our business growth was primarily focused in the United States, which provided a large part of the Group's overall business thanks to a substantial number of orders at the beginning of 2016. The Reinforced Earth Company (RECo) achieved some fantastic results in 2016 with an increase of 60% in operating profit, the result of several major projects such as the expansion of the Interstate 4 in Florida (I-4 Ultimate) and State Highway 183 in Texas. Our activity also grew substantially in Canada thanks to projects signed in 2015 for the Turcot Interchange in Quebec and the Regina Bypass in Saskatchewan, under Public-Private Partnerships (PPPs). Furthermore, we are growing our presence outside of North America and across the globe, with the exception of Europe where the market conditions remain tight.

A key moment this year?

The inauguration of the French SEA High-Speed Line (SEA HSL) between Tours and Bordeaux on 28 February 2017. Our teams took part in Europe's biggest rail construction project!

A watchword for 2016?

Transition. This took physical form in the business diversification that the whole Group has been working towards.

A reason to be proud?

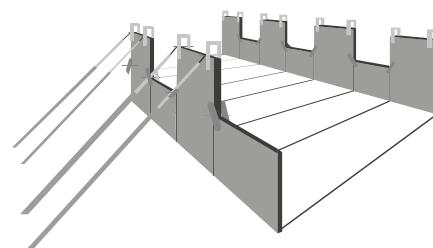
Our substantial progress in terms of safety: only one lost time workplace accident was recorded last year.

How do you explain these upbeat results?

In order to differentiate ourselves in increasingly competitive markets, we are building on our fundamental assets: "Excellence in Client Care", and innovation. The quality of our service is a significant asset. On PPP and design-build projects, the care we take in identifying our clients' needs, offering customised solutions and meeting budgets, deadlines and safety measures, represents clear added value. Those who regularly call on our services have understood this. It is up to us to persevere in making these qualities known to new partners.

Following the invention of Reinforced Earth®, French engineer Henri Vidal needed all the tenacity he could muster to turn his technological breakthrough into an entrepreneurial success story in the 1960s. That is the underlying principle of innovation...

Absolutely, innovation plays an integral part in our past, our present and our future, which is how we aim to respond to any new needs in changing markets. Reinforced Earth India, which celebrated 10 years in 2016, undertook projects in India using technologies



World leader in retaining structures

The Terre Armée Group, which introduced the Reinforced Earth® technique, has unrivalled experience in reinforced backfill and soil-structure interaction. Its techniques are applied in fields ranging from roads and motorways to railways, industry, the environment and hydraulic engineering.

800
EMPLOYEES

€215 m
REVENUE

18%
GROWTH IN 2016

NEW ORDERS

- NEON project, Las Vegas, Nevada, United States
- Structures for the Z-Morh tunnel, Jammu and Kashmir, India
- Los Angeles Rams stadium, Inglewood, California, United States
- Southwest Transitway, Winnipeg, Manitoba, Canada
- Toowoomba Range Crossing, Australia
- Second Iquique access road, Alto Hospicio, Chile

→ never seen before in the field of construction on steep and uneven ground stabilisation and protection against erosion. In France, our teams were heavily involved in the successful South Europe-Atlantic High-Speed railway Line (SEA HSL), for which they built Reinforced Earth® walls, which passed a series of tests for durability, reliability and deformability, thus demonstrating the suitability of this technology choice (see page 49).

What can be done to help promote the diversification of Terre Armée's business?

We hold a strong position in our traditional markets, but we want to strengthen our position in other sectors, such as railway and hydraulics (water works), through new applications of our current technology and in the development of new related products (see page 17). We also want to re-launch our activities in the mining sector, notably in Canada, South Africa and Australia.

How does the strategic "TA 2020" plan that you launched in 2016 provide clarity to your offer?

We restructured ourselves into eight regional poles, and we are working from a strong strategic plan which defines the platform and framework of our market positioning. Indeed, we are focusing on three distinct business lines: "Retain", for our retaining wall technology, "Cross", for highway and river crossings, and "Protect", for protection services. Our solutions for crossings include our TechSpan® precast concrete arch and our TechBox™ precast framework technologies. As for our protection services, this is likely to be our biggest area for growth in the future and we are investing in research and development for multiple coastal protection and erosion control solutions, as well as avalanche and rockfall protection barriers.

What is the outlook for the coming years?

With an order backlog for 2017 already roughly equal to our revenue in 2016, the year is off to a promising start. Beyond these indicators, our success depends on our expertise, as well as the ingenuity and the passion of the men and women who make up the Group. Terre Armée will continue to invest so that its teams can keep coming up with the innovative, reliable and durable solutions who are the key to its success. The Orchestra technical training we introduced in 2016 is also a part of this effort.



SEA HIGH-SPEED LINE: A TRANSFORMED TEST



On 5 August 2016, the train carrying out high-speed testing on the French new South Europe-Atlantic line between Tours and Bordeaux reached the speed of 352km/h and crossed one of the eight structures built with Reinforced Earth® retaining walls along the tracks. With commercial service set to start on 2 July 2017 (at an operating speed of 320km/h), the tests carried out over the summer marked the end of a technical and human marathon.

A world first in railway construction

Terre Armée innovated by proposing the first-ever use of its retaining walls along railway lines used by high-speed trains. Its teams worked for nearly three years on an alternative technical solution that is as reliable as the baseline solution and accommodates the demanding design and approval process at Réseau Ferré de France (now SNCF Réseau). A total of 11 structures were built using the Reinforced Earth® retaining wall solution, with nearly 8,500 sq. metres of facings and 20 walls including 16 very high structures (up to 12.70 metres) at the ends of grade separations. The height, and above all the 352km/h train speed supported by the walls, are a record for Terre Armée. The Reinforced Earth® design took account of the high sensitivity of the infrastructure to deformation caused by passing high-speed trains (the "track twist" criterion, i.e. 15mm of distortion per 3 metres of track) and the full range of railway sector requirements with respect to access for maintenance purposes and structure stability and load bearing conditions.

An unrivalled level of design studies for a reliable and durable solution

To meet the exacting requirements, an unprecedented number of studies were carried out. Geotechnical and seismic validation was performed as was a digital simulation of vibrations caused by high-speed trains in order to study the effect of compression and shear wave propagation on the backfill as trains pass. The Reinforced Earth® structures are adapted to a variety of roadbed conditions. The flexible retaining structures make it possible to carry out optimised soil reinforcement works that incorporate consolidation times. This either eliminates the need for deep foundations, as in the Monts structure, south of Tours, or replaces them with rigid inclusions. In addition, Reinforced Earth® offers high resistance to static and dynamic loading and can therefore be used to build high structures without particular constraints. The process facilitated construction of structures along the alignment and eliminated the need for heavy protective temporary barriers.

Lastly, a detailed monitoring programme was set up for each structure to detect any deformation in the facings over time. Instrumentation was also provided in the retaining walls along the tracks on which trains travel at 352km/h. A special campaign was carried out to specifically measure stresses and accelerations during the testing phases to gain unprecedented feedback prior to the start of operations.

Better control of the multiple interfaces between activities



Christophe Persoz - COSEA

Deputy Director of the Infrastructure sub-consortium (SGI) at COSEA, in charge of design and build of the SEA High-Speed Line, France

"In the course of our work with Terre Armée, we were first reassured by a lightweight, reliable and durable solution that gave us flexibility in construction scheduling and better control of the multiple interfaces between activities. The main advantage of the solution is that it can be rapidly implemented, which optimises costs and supports on-time delivery based on unrivalled expertise in structural engineering, construction and material management. The Terre Armée teams were persevering, consistent and very energetic. The project involved completing a series of analyses and studies, finding a correctly dimensioned solution and obtaining the permit approval – an obstacle course requiring endurance and performance. We also appreciated the uninterrupted availability of the operational teams, who were attentive and supported us throughout the process with a straightforward, strong partnership."

B2 viaduct on the E75 motorway
Demir Kapija-Smokvica, Macedonia



25
METRES

It is the maximum height of the Reinforced Earth® retaining walls along the access to the B2 viaduct carrying the E75 motorway at Demir Kapija in southern Macedonia. Terre Armée France teams were in charge of replacing the first southern spans of the viaduct, which crosses a railway line and the Vardar River. The construction of the very high wall was spread over more than a year and the installation of 7,100 sq. metres of TerraClass® facing panels was completed in October 2016. The project, carried out for Egis in a joint venture with IRD Engineering, is part of the broader construction of nearly 29km of lines carried out by the Greek company Aktor (Ellaktor Group) as part of the European Union's transport infrastructure development programme, the Trans-European Transport Network (TEN-T).

North West Corridor express lane project
Atlanta, Georgia, United States



Improving mobility and simplifying life for motorists around Atlanta

This is the double challenge taken up by The Reinforced Earth Company USA (RECo) under the auspices of the Georgia Department of Transportation (DoT). Under a large design-build programme covering 48km of toll lanes conducted in a joint venture with Eurovia, the local subsidiary provided MSE retaining walls to maximize the narrow space available along parts of I-75 and I-575, northwest of Atlanta, to construct additional lanes that are reversible depending on peak periods of traffic flow. The teams supplied 59,300 sq. metres of Reinforced Earth® walls and 22,300 sq. metres of precast facing panels for 16 structures. Deliveries of concrete wall panels, steel reinforcing strips and other materials needed for the walls were precisely phased to adapt to the constraints of a very limited on-site "laydown" area, and to contribute to the overall productivity and performance of the site. The lanes are set to open in May 2018.

Combating water shortages



Muak Lek reservoir
Saraburi Province, Thailand

Despite the abundant rains of the monsoon, water shortages are declared in dozens of provinces in Thailand every year. The authorities therefore introduced development programmes in the early 1990s to improve management of the available water resources. The Muak Lek reservoir, about 100km from Bangkok, is designed to supply water to the inhabitants of Wang Muang district and boost fishing, agriculture and tourism. The Reinforced Earth Company (RECo) is taking part in this huge project by helping to build the road that travels along the edge of the reservoir. It is 2.730km long and made up of nearly 9,000 sq. metres of TerraSquare® panels. Reinforced Earth® retaining walls are built along 1.320km with a maximum height of 11 metres. RECo's design, supply and installation expertise significantly reduced the cost of construction in terms of chosen fill and compaction works. The second phase of work started in October 2016.



Building in a seismically active area

Tierra Armada de México is building a cable-stayed bridge abutment for construction group EPCCOR. The structure is a key part of the motorway that will connect Rizo de Oro and La Concordia in southeastern Mexico. This is the first bridge of its type to be built in the Chiapas region. In December 2016, the abutment's Reinforced Earth® walls reached the required height (21 metres) for the construction and launching of the superstructure to begin. The teams will then finalise the 3,500 sq. metres of the wall, which will have a top height of 26 metres. The Group's Mexican subsidiary provided the expertise needed to combine the design requirements with a construction process geared to the constraints of the region that will prevent the effects of seismic acceleration on the structure throughout its life cycle.

La Concordia Bridge La Concordia, Chiapas, Mexico



January 2017: the first diamonds from the Liqhobong mine sold in Antwerp

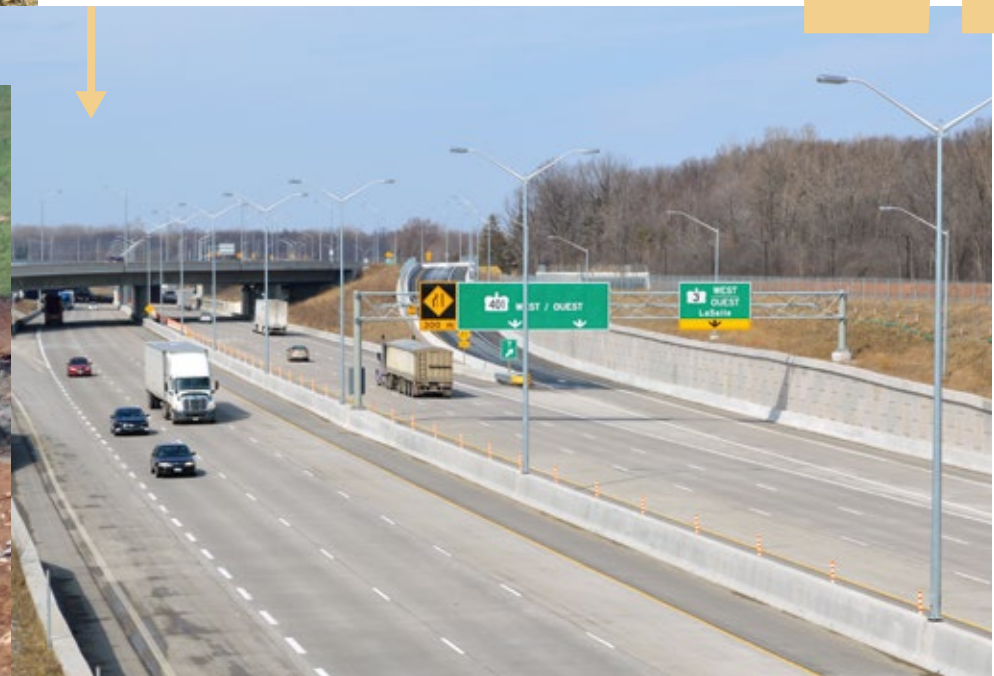
A yield of one million carats a year is expected over the 15-year life of the open pit diamond mine high up in the Maluti mountains in northern Lesotho, which lies at an altitude of 2,330 metres. In February 2016, Reinforced Earth South Africa (RESA) worked on the development of the mining complex, where it was awarded the contract covering design and supply of drawings, equipment and technical assistance for the construction of the site's primary crusher plant. The contract includes construction of 796 sq. metres of Reinforced Earth® walls with TerraClass® concrete facing panels using high-adherence galvanised steel reinforcing strips and 498 sq. metres of retaining walls for the main treatment plant. RESA developed innovative "compressible panels" suited to the logistical challenge of bringing in equipment over a 12km mountain road and cast on site by the contractor in charge of the project, Stefanutti Stocks.

Liqhobong Mine Butha-Buthe District, Lesotho



After five years of work, Reinforced Earth Company Ltd. (RECo) in Canada has delivered close to 38,000 sq. metres of TerraClass® retaining walls as part of the biggest-ever completed Public-Private Partnership (PPP) in Ontario. In July 2016, this vast road infrastructure project won the Environmental Achievement Award from the Transport Association of Canada (TAC). RECo Canada teams contributed to building this 11km green highway, helping to reduce the impact for residents on the towns it passes through, to ensure the safe movement of people, goods and services and improving traffic flow on this major trade link with the United States. It will link the cities of Windsor and Detroit by connecting the Canadian Highway 401 to the American Interstate 375. RECo Canada took charge of the design and supply of retaining walls for 71 structures along this entirely excavated highway, which includes 11 tunnels. The company used cellular concrete for the embankment, given the poor quality of the foundation soil. All staff received safety and environmental training so they would be aware of the constraints of the local ecosystem, and a construction timetable was drawn up to respect protected species living in the zone. Many recreational trails, including ten pedestrian bridges with TerraClass® retaining systems, and green spaces were created for hikers and cyclists to enhance this busy highway.

11km



The Rt. Honorable Herb Gray Parkway Ontario, Canada