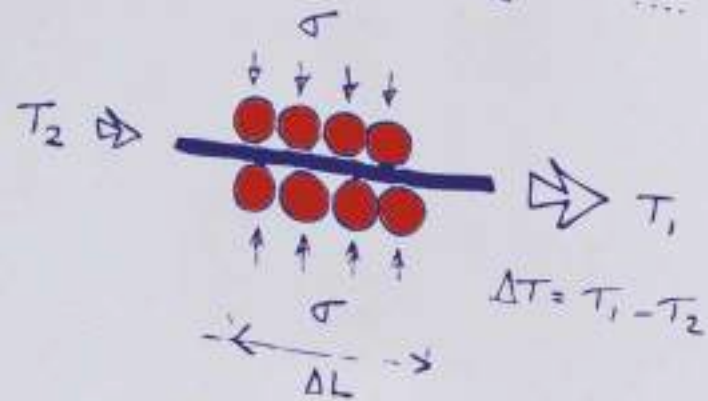




REINFORCED EARTH

IF $\Delta T < 2[\sigma \tan \phi] \cdot \Delta L \dots$



... 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.

REINFORCED EARTH

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

Reinforced Earth 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

Reinforced Earth 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 100,000 structures around the world

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's reliability and durability. They are guided by the same visionary spirit that marked the inception of the Reinforced Earth company.

NETWORKED EXPERTISE

Thanks to its international presence, Reinforced Earth 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.

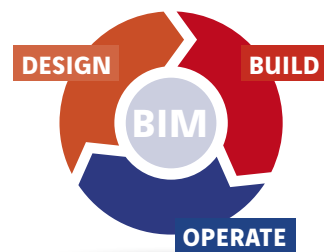
ADDRESSING THE CHALLENGES OF THE FUTURE

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.

WORKING TOWARD WIDESPREAD USE OF BIM

Reinforced Earth is investing in BIM (Building Information Modeling). The digital model of the structure is used to integrate the full range of documentation. This enables all stakeholders to readily access justification, traceability and construction documents throughout the project.



1,500
patents filed
worldwide

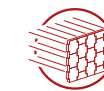
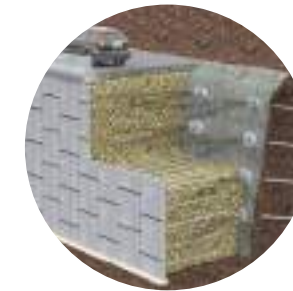


TECHNICAL SOLUTIONS AND SERVICES

Optimising the performance of each structure

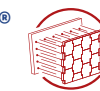
Reinforced Earth offers its clients optimised state-of-the-art solutions. Our baseline services include structure design, supply of the specific components and training of the teams in charge of construction. This ensures overall project consistency and success. Since inventing Reinforced Earth®, we 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.



TERRALINK™
The logical complementary innovation

In projects combining excavation and backfill, the technique builds a Reinforced Earth® in front of another retaining structure.



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.



TECHBOX®
The precast concrete box system

This solution is used to build a box structure under backfill.

MAJOR STAGES OF A PROJECT

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

1 DESIGN

The Reinforced Earth 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



BUSINESS LINES

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

RETAIN, CROSS, PROTECT.

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

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



RETAIN

55 million sq. meters of Reinforced Earth® walls worldwide



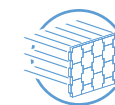
road widening
retaining walls **RETAIN** dams
loading docks reinforced embankments
access ramps grade separations

Retaining structures

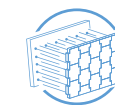
Building on its one-of-a-kind expertise in soil-structure interaction, the Reinforced Earth Group designs a wide variety of retaining structures.

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.

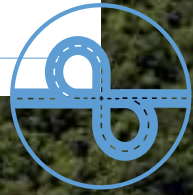




**REPUBLIC
OF MACEDONIA**

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. Reinforced Earth 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, Reinforced Earth 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. Reinforced Earth 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, Reinforced Earth 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



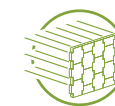
avalanche barriers
 blast protection walls rock shed structures
 embankments **PROTECT** slope stabilisation
 protective berms breakwaters

Protective structures

Reinforced Earth 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.





ISLANDE
Seydhisfjörður
avalanche barrier

The village of Seydhisfjörður lies encircled by three mountains at the bottom of the longest fjord in the eastern part of the island. To protect it from avalanches, Reinforced Earth 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.



-  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, Reinforced Earth 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 Reinforced Earth.



APPLICATIONS

Reinforced Earth designed structures are suitable for a wide variety of uses.

The **RETAIN**, **CROSS**, **PROTECT** 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 and protection structures 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 Reinforced Earth 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

Reinforced Earth delivers solutions for airport expansion projects. The Reinforced Earth® 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, Reinforced Earth designed and supplied 53,000 sq. meters of 19 meter high Reinforced Earth® walls.

SWAZILAND

Mbabane junction

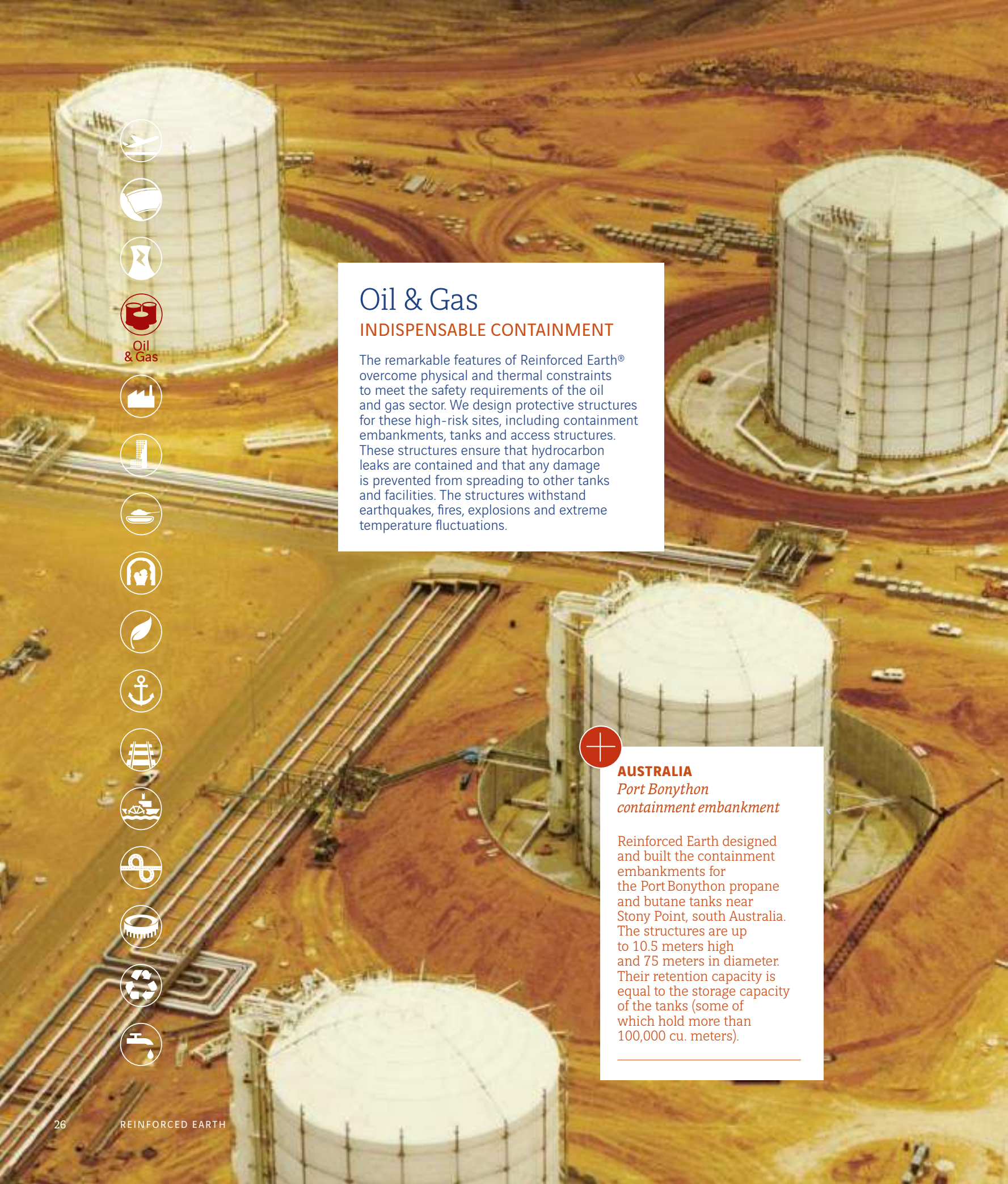
The motorway bypass in the capital of Swaziland is 12 km long. For this major infrastructure project, Reinforced Earth designed and supplied 18 retaining walls with a height of more than 30 meters, and 16 bridge abutments. The combined surface area is 36,000 sq. meters.



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.



Oil & Gas

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*

Reinforced Earth 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.



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

Reinforced Earth 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 Reinforced Earth® 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. Reinforced Earth® is also combined with a waterproofing system to build drinking water reservoirs. Reinforced Earth 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. Reinforced Earth 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.



Environment

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

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

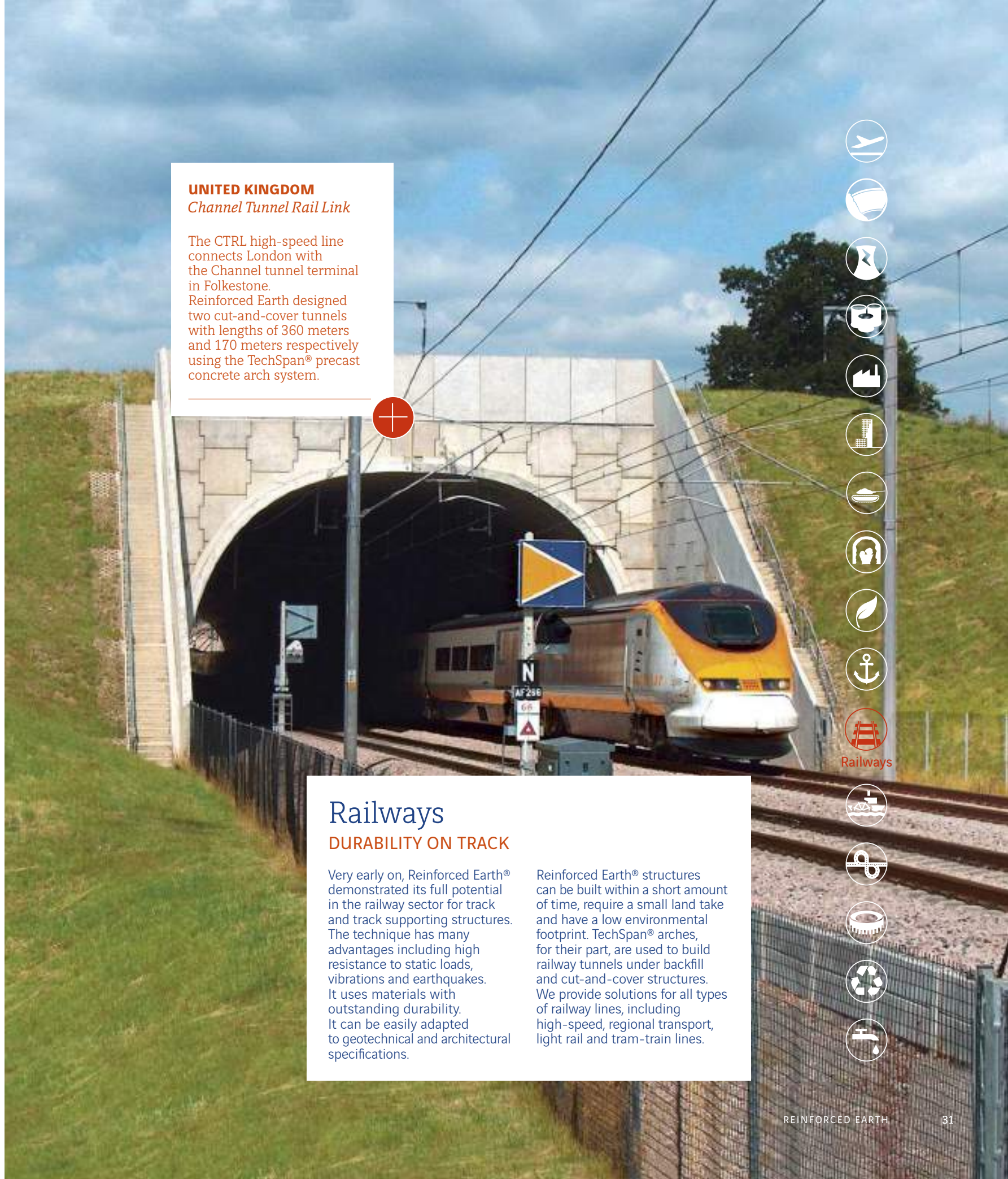
Ports & Coastal sites

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. Reinforced Earth 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 REINFORCED EARTH SPIRIT

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



OUR TEAMS

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

A COMMUNITY OF EXPERTS

The people at Reinforced Earth 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 Reinforced Earth subsidiaries. Our internal network of experts supports their specific needs.

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 and excellence. Safety is a strong part of Reinforced Earth 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 Reinforced Earth. The quest for excellence guides our teams in their decision-making and their actions.

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 Reinforced Earth's excellence goals and reinforce our community of experts.



SAFETY

Reinforced Earth applies a rigorous safety policy across all its subsidiaries. The goal is Zero Accidents.

TRAINING AND AWARENESS

To control risks, we painstakingly train all employees in safety. The goal is to develop their skills and raise their awareness to ensure that they are proactively involved in accident prevention and safety.

MANAGERIAL LEADERSHIP

Managers at all levels are closely involved in the safety policy. They set an example, ensure effective implementation of safety measures and pay close attention to feedback from the teams in the field.

HEALTH AND SAFETY IN THE FIELD

The goal is to control risks and to reduce the number and severity of accidents. Our employees wear safe personal protective equipment. They methodically plan and prepare each job in the field and secure the worksite environment. They are able to identify dangerous situations in order to better address them.

SAFETY DESIGNED INTO THE STRUCTURE

From the design stage onwards, our engineers devise safety systems to ensure that our people on the ground can work safely.





ENVIRONMENT PROGRAMME

Starting with the initial design studies, Reinforced Earth designs solutions for sustainable structures with low environmental impact.

CONTROLLING ENVIRONMENTAL IMPACT

Our engineers design technical solutions requiring smaller volumes of materials (concrete, steel) than conventional construction methods. 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. In addition, our techniques are able to use recycled materials to build reinforced backfill at some sites.

SUSTAINABILITY

The intrinsic qualities of our retaining, crossing and protection structures enable them to withstand extreme stress. Their resilience is particularly remarkable in an earthquake. Lastly, the Reinforced Earth® technique lends itself

to a very wide range of aesthetic treatments and such structures blend perfectly and sustainably into the natural or urban environment.

INNOVATION

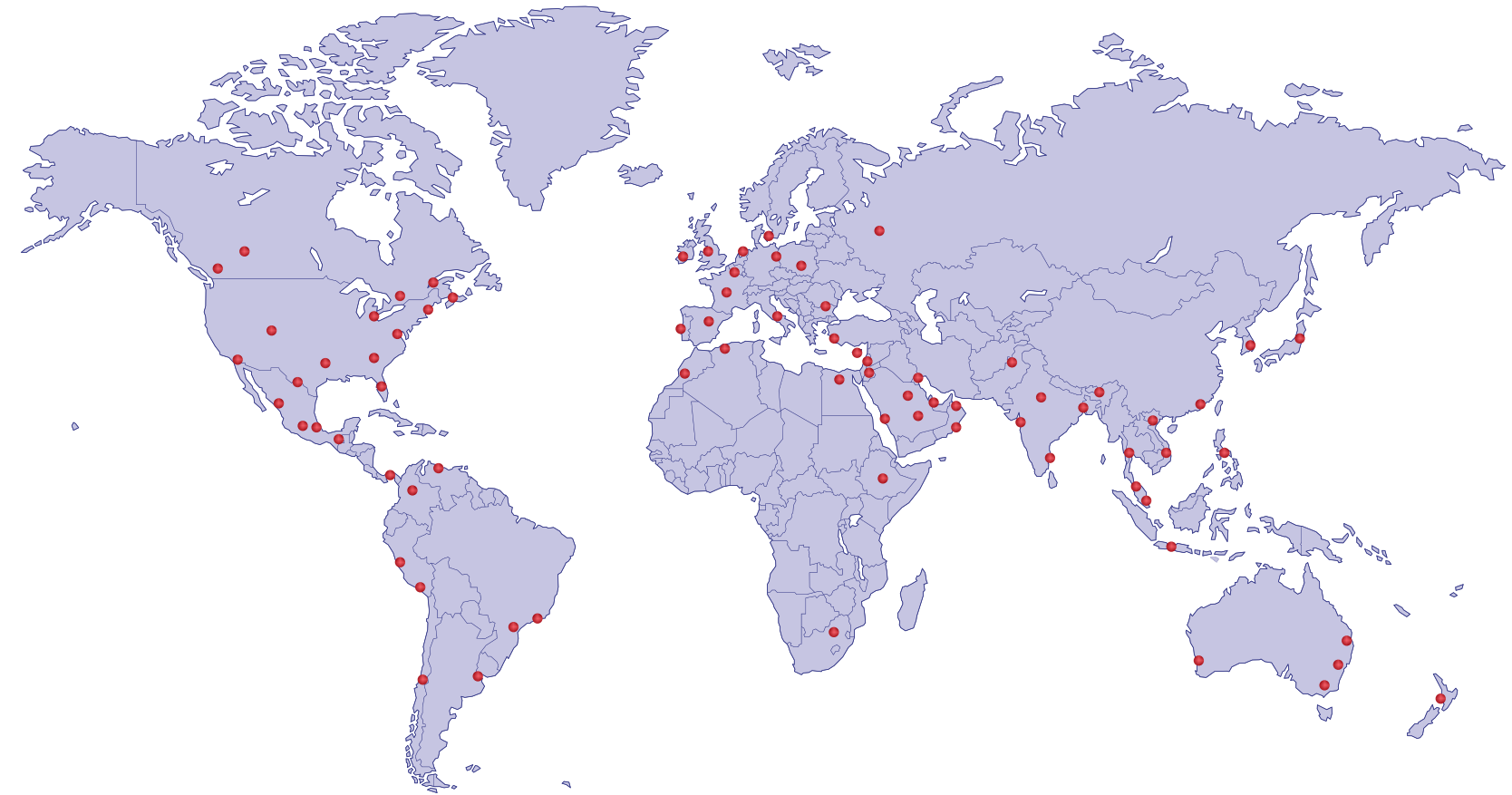
Our R&D programs enable us to design increasingly efficient solutions that keep pace with environmental goals.

LONG-LASTING INFRASTRUCTURE

In a natural event, our prevention and protection solutions limit damage to facilities. We also build structures to protect people and property from accidents at industrial sites.

WHERE TO FIND US

Reinforced Earth has locations in 45 countries to support you around the world.

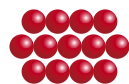


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