GEOQUEST

Railways

An innovative solution with a successful track record of over 50 years

In the early 1970s, the field of civil engineering was revolutionized by the introduction of the Reinforced Earth® technique, an innovative and economical way of building retaining structures. The rapid development of Reinforced Earth® allowed for its first use in the railways sector only 5 years after its inception.

By the mid-seventies, the civil engineering community began to take notice of the potential of this unique construction method, particularly in terms of its ability to bear dynamic loads. Engineers and project owners soon began to employ the Reinforced Earth® technique extensively for building structures under railway tracks, where heavy loads and vibrations posed significant challenges.

Since the construction of the first walls supporting a railway line in the USA in 1973, hundreds of Reinforced Earth® structures were designed and built for railway applications, including retaining walls, bridge abutments, and cut and cover tunnels.

Providing safe, reliable and durable solutions

Safety is a critical aspect of railway infrastructure development. Ensuring the safety of passengers, as well as the integrity of the infrastructure itself, is of outmost importance. Reinforced Earth® engineered solutions are specifically designed to provide a high level of safety and reliability in railway infrastructure. Design is tuned to consider specific requirements concerning surcharges or safety cœfficients, especially for high-speed trains. With Reinforced Earth® engineered solutions, railway infrastructure owners and developers can achieve the highest standards of safety, reliability and comfort of passengers for years to come.

Engineering excellence

Geoquest's engineering teams regularly perform specific modelling and analysis to anticipate the behavior of your railway structures operating under a wide range of conditions. Our approach to designing railway structures and the associated earthworks encompasses a thorough visualization of your railway project requirements, considering:

- Foundations, settlement, and drainage
- Traffic loads
- Centrifugal loads (rail curvature)
- Heavy vibrations and seismic performance
- Ballast freeboard
- Overhead Catenary Systems (OCS)

The Reinforced Earth® solution, a perfect fit for a wide range of railway applications

Whatever the type of train, LRT, MRT, regional, intercity, high-speed rail or freight, many solutions can be offered including:

Main applications

Structures along railways

- Retaining walls and noise barriers
- Steep embankments for noise and collision protection

Haan-Gruiten - Germany

Structures over railways

- Access ramps to railway flyovers
- Bridge abutments spanning over railway lines
- Rail tunnels beneath earthen embankments
- Wildlife crossings/Ecoducts

Channel Tunnel – United Kingdom

Structures under railways

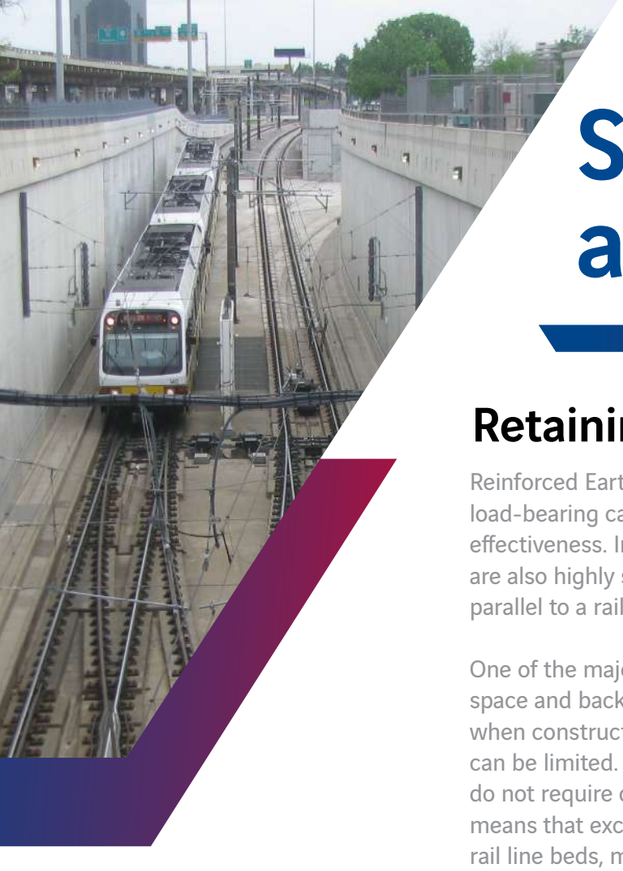
- Retaining walls and bridge abutments supporting track beds, including along rivers and waterways
- Arch bridges supporting track beds
- Underpasses and culverts beneath earthen embankments supporting track beds
- Ballast and sub-ballast reinforcement, and subgrade stabilization

Fort Worth Intermodal - USA

Protection against natural risks

- Erosion and scour protection
- Rockfall and debris flow protection
- Slope stabilization

Karvanati River - India



Structures along railways

Retaining walls along railways

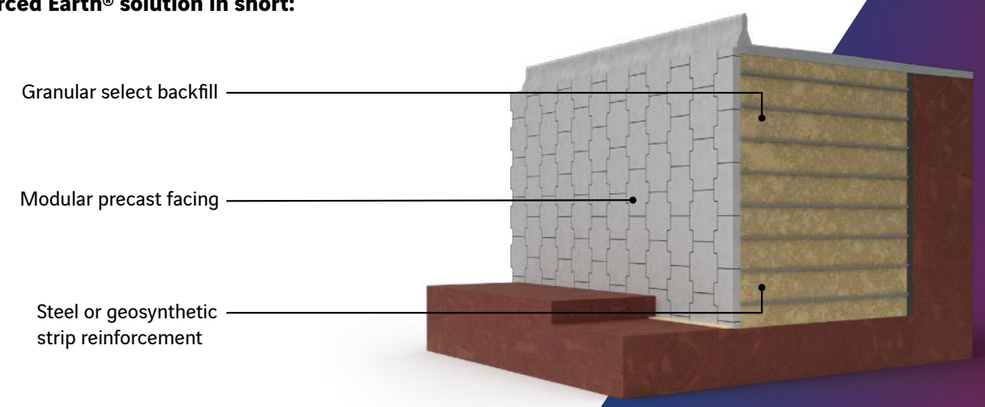
Reinforced Earth® structures are renowned for their excellent dynamic load-bearing capacity, resilience, speed of construction and cost-effectiveness. In addition to these primary advantages, these structures are also highly space-efficient, making them ideal for constructing walls parallel to a railway line.

One of the major benefits of a Reinforced Earth® structure is its minimal space and backfill depth requirements. This is particularly important when constructing walls adjacent to a railway line, where available space can be limited. Unlike other types of structures, Reinforced Earth® walls do not require deep foundations or footings beyond the front face. This means that excavations can be completed without encroaching upon the rail line beds, minimizing disruption to rail services.

This ideal combination creates a durable and resilient retaining wall solution. Furthermore, Reinforced Earth® walls can be constructed entirely from the backfill side, without the need for scaffolding or any other structure or equipment in front of the wall. This not only saves time and money but also enables the wall to be positioned directly up to a clearance line or service road, without any serious disruption to rail services.

Geoquest also offers precast retaining walls. TechWall™ consists of full-height precast panels cast with integral counterforts. These panels are jointed at the base with a cast-in-place footing. TechWall™ elements perform as cantilever T-Beams in resisting lateral earth pressure, and therefore, a thin concrete facing can be used. It is ideal when jobsites present a narrow workspace and complicated cut conditions.

The Reinforced Earth® solution in short:



Solutions for noise protection

Noise and vibratory disturbance induced by railways developed in urban or residential areas can be mitigated by constructing Reinforced Earth® walls with noise absorbing panels or precast concrete noise barrier solutions.

The Reinforced Earth® method can also be used to build embankments along railways to provide protection against environmental nuisances such as noise or visual pollution. Such structures can also be efficient safety barriers against collisions especially in the case of corridors combining high speed railways and highways, due to the inherent resilience of the Reinforced Earth® technique. To optimize the land use and consumption of materials the faces of the embankments can be subvertical or steepened, with mineral or vegetated facings.


DART Blue Line - USA


A4-Hörselgau - Germany

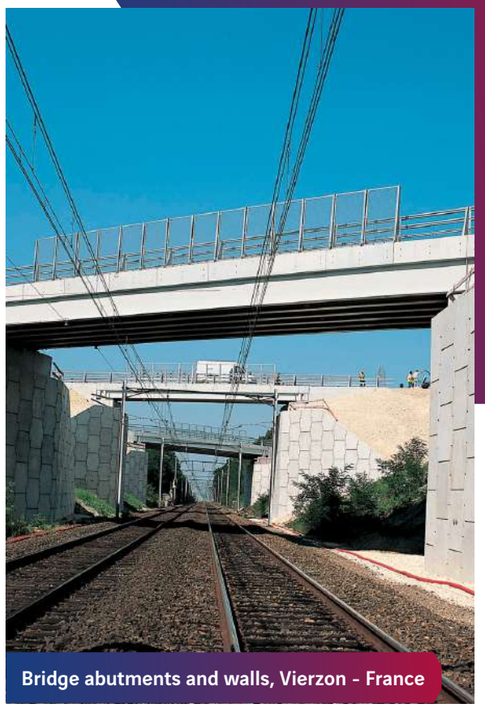
Structures over railways

Reinforced Earth® true, mixed and integral abutments

Building new structures crossing over railways can often be challenging due to several constraints such as the limited available workspace or possible traffic disruption.

Bridge abutments, when built with traditional cast-in-place solutions, require steel shoring that may hinder the continuous flow of trains and require deeper excavation. Construction constraints can be even higher when the structure is built on piles due to the space required for the drilling or driving equipment.

Reinforced Earth® bridge abutments, as for walls, are built from the backfilling side, allowing for very limited exposure to the traffic area. Reinforced Earth® abutments can also be built on shallow foundations on poor soils.



Bridge abutments and walls, Vierzon - France

President George Bush Turnpike, Carrollton - USA

Overall, the use of Reinforced Earth® for such overpass applications limits traffic disruption, allows for rapid and safer construction and for design options based on sites conditions and owner's requirements since structures can be pure or integral load bearing abutment, or mixed abutments.

Rail tunnels under embankments and cut and covers

TechSpan® arches are frequently used for the construction of railway tunnels in earthen embankents or in cut and covers. This construction method, involving a strong soil-structure interaction, associates three-pin prefabricated concrete arches to a select backfill.

A buried overfilled precast arch structure, TechSpan® generally consists of matching arch units that connect structurally at the crown, and are supported by a "sized-for-site" footing. These structures accommodate high fills, heavy live loads, and altering load conditions often associated with railways.

TechSpan®'s funicular curve minimizes tensile forces in the arch, therefore creating an axially compressed structure leading to increased durability and costs savings. Designs are supported by Finite Element Method (FEM) analyses to verify load conditions for each step of construction. Engineers can either select from a wide range of standard arch shapes at the dedicated website **www.precastarches.com** , or should contact our local office for developing a customized shape.

The main advantages of the TechSpan® technique are the material and structural quality, the rapidity of installation and the adaptability to the specific requirements of each project. TechSpan® is especially efficient when building the structures over existing rail tracks under traffic when closure is not an option. Reinforced Earth® is a logical complementary technique for the construction of the spandrel walls.

Installation of TechSpan®, Mandurah - Australia

TechSpan® rail underpass - UK

North Kiama Bypass - Australia

Wildlife crossings – Ecoducts

Ensuring the safety of passengers at all times while preserving the natural environment is a major challenge for railways developers. Geoquest offers various solutions allowing animals to safely cross rail infrastructure and prevent any collision.

Snoqualmie wildlife crossing - USA

A432 wildlife crossing - France

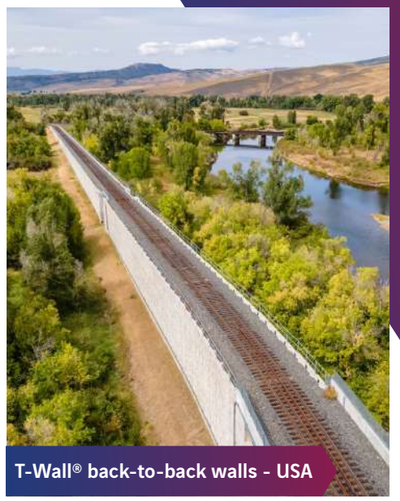
Under railways

Retaining walls supporting railways

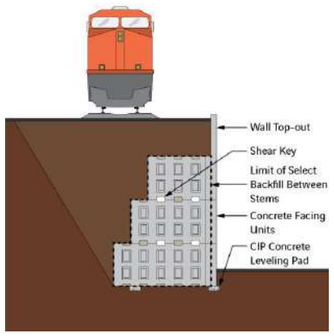
Over the years, our retaining solutions have been used around the world to build new structures supporting railway lines or to widen existing ones. Our engineering teams have gained strong expertise in designing structures supporting mass transit, heavy rail and high-speed rail.

Designing such structures implies taking into consideration various critical parameters associated to such dynamic loads and allowing for an optimal preservation of the infrastructure's geometry, accommodating for various levels of vibrations and sudden braking decelerations.

Based on more than 40 years of return on experience for such structures and test conducted in the USA, France and Germany, our engineering teams can optimize designs while answering to the highest safety standards and limiting long term maintenance needs.



T-Wall® back-to-back walls - USA



Typical T-Wall® cross section

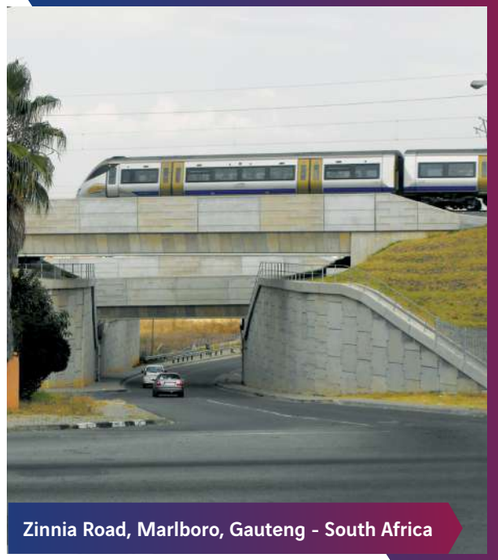
In addition to the world-renowned Reinforced Earth® solution, Geoquest also offers the TechWall™ precast cantilever and the T-Wall® precast modular retaining walls.

T-Wall® has in fact proven to be an excellent fit when used for the construction of structures supporting railways. The solution consists in placing robust, standalone concrete units that are cast with perpendicular stems attached to rectangle or square facing, which together form the shape of a "T".

Heavy Rail, Union Pacific Link - USA

Bridge abutments supporting the track beds

Among its many earth-retaining and load-supporting applications, the Reinforced Earth® method has gained world wide acceptance as an economical and technically superior construction method for bridge abutments. This eliminates the need for pile supports or other costly foundation improvements. Reinforced Earth® railroad bridge abutments have been built in several countries since 1975. These are designed to withstand the heavy bearing pressure and braking stresses transmitted through the track bed. The deck is directly supported by the Reinforced Earth® structures. The latter are built simultaneously with the approach embankments. With proper fill quality and compaction, a regular longitudinal profile is obtained, even in the case of poor foundation soils.

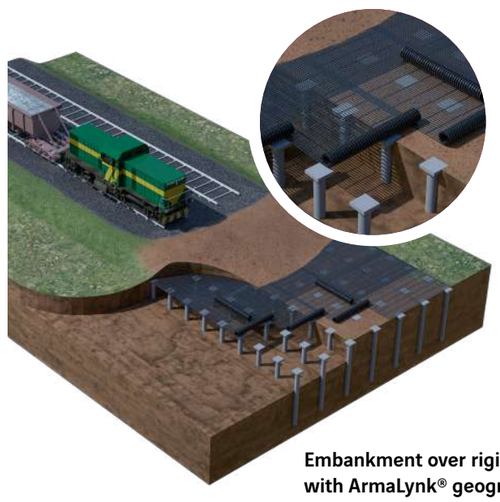


Zinnia Road, Marlboro, Gauteng - South Africa

Precast arches supporting rail tracks

TechSpan® precast arches can also be designed to support railway tracks.

Butler extension rail - Australia



Embankment over rigid inclusions with ArmaLynk® geogrid

Basal reinforcement

Building linear infrastructure such as railways can be challenging for design engineers when built over poor soils. Wherever basal reinforcement is required to build embankments over soft soils, over piles or over subsidence, the ArmaLynk® high-tensile strength geogrid is a superior solution for a premium level of differential settlement control and load spread.

ArmaLynk® can be manufactured with nominal strength reaching up to 1600kN/m and rolls can be customized and adapted to project specifics.

Ballast and sub-ballast reinforcement, and subgrade stabilization

Dynamic loads and constant trafficking have a direct impact on railway infrastructure. Preserving track alignment and preventing ballast displacement are keys for optimized performance. The use of Geoquest geogrids will reduce ballast settlement and degradation under the influence of traffic, will reduce maintenance and increase service life, therefore resulting in long term savings.

Offered in either biaxial or uniaxial form, and manufactured of either polyethylene or high-tenacity polyester, Geoquest's ArmaGrid® geogrids will help you build over soils that indicate a low bearing capacity.

Basal reinforcement with biaxial geogrids - Peru

Solutions for protection against rockfall and avalanches

Reinforced Earth® rockfall protection

Protective embankments

It is not uncommon for railway developers to require building protection from rockfall, avalanches and landslides in proximity to the railway. Geoquest offer engineered solutions that help protect railway alignments from gravity-related risks.

Geoquest's rockfall protection embankments are high-performance, narrow barriers that withstand energy impacts exceeding 5000 KJ. These barriers are typically constructed with wire mesh facings and geosynthetic soil reinforcement.

Reinforced Earth® embankments faced with steel mesh are also an excellent option to build avalanche barriers, splitters and catching dams. Design can be adapted with facing angles varying from 34° to 76°.

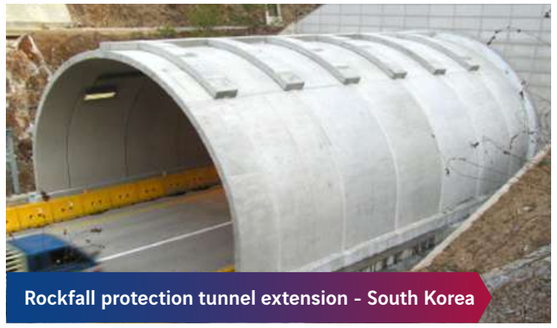
Avalanche barrier - Iceland

Avalanche protection - Iceland

Rockfall sheds and galleries

Used to span railways and roads in mountainous areas prone to rockfall, avalanche and landslides, TechSpan® arches and TechBox™ precast boxes function as tunnel extensions at daylighting points, or any passageway prone to such risks.

Rockfall protection shed - Spain



Rockfall protection tunnel extension - South Korea

Erosion and scour protection

Geoquest's solutions for erosion and scour protection are designed to protect assets from being exposed to related risks. Lines built near water streams or bridges built to cross rivers require thorough design of protective solutions.

The wide range of solutions offered by Geoquest include TechRevement™ and Hydrotex® fabric formed concrete mattresses which are manufactured and customized based on projects characteristics, ensuring for an optimal protection of assets and passengers.

TechRevetment™, Karvanati River - India

High-Speed Rail line Tours-Bordeaux, France - A milestone for Reinforced Earth® structures

In 2017, the high-speed passenger rail line linking the cities of Tours and Bordeaux in southwest France was put into operation, marking the successful finish of the South Europe-Atlantic High-Speed Rail line (SEA HSR). The project consisted of building 302 km of line and 10 connections along the 38 km link.

Following a comprehensive cost analysis, design review, and approval process carried out by the main contracting authority (SNCF), Geoquest was chosen by SEA's infrastructure design-build consortium (LISEA) to furnish as-built designs, materials and technical assistance for building 11 structures consisting of 20 Reinforced Earth® mechanically stabilized earth walls (MSE).

Upon completion, 8,500 m² of wall was built, 16 of which reached heights up to 12.7m tall. Engineers, Project Managers and Technicians from Geoquest were mobilized for nearly three years to complete the project.

In retrospect, as part of the research and development program, a Reinforced Earth® wall supporting a track with live trains travelling at speeds up to 352 km/h was instrumented and monitored. The positive results of this unprecedented collaborative program, the first of its kind ever in the world, provided real-time specific dynamic stress and acceleration measurements during the trial phase prior to the line being put into service.

LGV Poitiers Sud - France

Rail references

Brightline Orlando Extension – USA

Kyung Bu high speed train - South Korea

Snider Diamond grade separation - Canada

Kennesaw - USA

Trillium Line - Canada

Etihad Rail – United Arab Emirates

Bandirma-Bursa-Osmaneli-Ayazma High Speed Rail Project - Turkey

Engineering expertise, innovation and excellence in client care to deliver sustainable solutions.

GEOQUEST

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