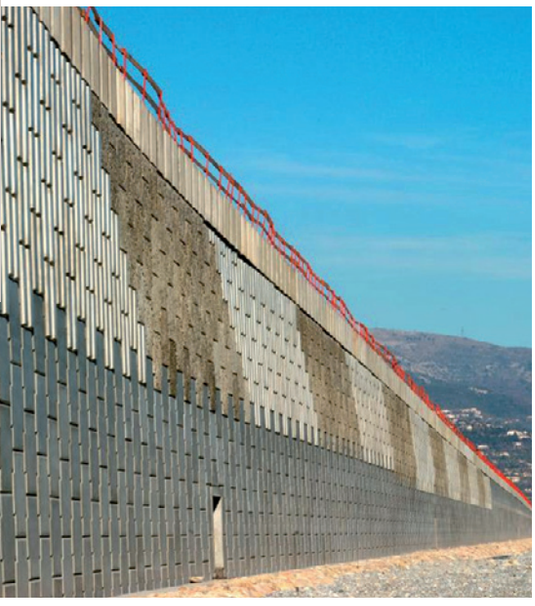
Risk Mitigation

Reinforced Earth® protective structures



REINFORCED EARTH

SUSTAINABLE TECHNOLOGY

Natural disasters

Izmit earthquake (Turkey)

Avalanche barrier - Neskaupstadur (Iceland)

Tunnel extension - Hyeongok (South Korea)

Avalanche barriers - Seydisfjörddur & Isafjördur (Iceland)

Throughout history Nature's forces have proven to be overwhelmingly dangerous causing heavy loss of life, injuries and extensive damage to property. The Reinforced Earth® technique can help mitigate the consequences of such natural disasters providing such protection through its intrinsic characteristics.

Earthquakes

An effective way for a structure to resist strong motions due to seismic activity is to exhibit sufficient flexibility in order to dissipate the applied energy while not attracting detrimental loads on critical structural elements. The inherent ductility and resilience of Reinforced Earth® structure justify its high degree of acceptance in regions exposed to earthquakes. There are many documented examples of excellent performance during seismic events.

Avalanches

With the same philosophy of resilience and flexibility, Reinforced Earth® structures are commonly used to protect properties and commodities against avalanches. Using steel mesh facings of systems such as TerraTrel® or GeoTrel® provides additional flexibility while allowing easier logistics and construction in remote areas or sites with difficult access.

Rockfalls and slope failures

TechSpan®, a precast arch system developed by Terre Armée Internationale, provides protective solutions to mitigate the risk of rockfalls and slope failures at the extremities of tunnels. TechSpan® arches can be designed to fit exactly to the shape of the tunnel and can be installed without disrupting the flow of traffic.

Floods, tsunamis, mud and lava flows

Due to its lower use of construction materials compared to regular embankment and its suitability to build vertical and battered walls, as well as steepened slopes, the Reinforced Earth® technique is a perfect solution for protection dikes or channeling walls against a variety of potentially hazardous naturally aggressive events such as water in case of floods or tsunamis, but also debris flows and even lava.

Land slides

By minimizing the quantity of building materials, Reinforced Earth® is a flexible and easy-to-build technique which has been used in some specific cases to provide active protection against potentially hazardous landslides.

Sea wall - Gaspé (Canada)

Sunset Cliffs - California (USA)

Stabilization of landslide - Cairnmuir (New Zealand)

Industrial hazards

Containment dikes for ammonia tanks – Montoir (France)

After the oil tank fire - Tacoa (Venezuela)

Blast barrier - Townsville (Australia)

Rocket launching pad - Kagoshima (Japan)

Within an increasingly regulatory framework regarding the potential for industrial explosions, fire and pollution, the use of the Reinforced Earth® technique for vital structures designed to protect against such hazards has been a logical extension of the technology after its performance has been established in other applications.

Containment

The Reinforced Earth® method is used to construct safety dikes around large tanks of liquefied natural gas (LNG) or other volatile liquid petroleum products. In the event of a rupture in one of these tanks, the function of a Reinforced Earth® dike is twofold: containment of the escaping fluid and prevention of damage to nearby tanks and facilities.

Fire and thermal shocks

Reinforced Earth® with steel soil reinforcements is an ideal material for the construction of industrial protective structures since its components: earth, steel soil reinforcement and concrete facing are substantially non flammable and resistant to thermal variations. Tests conducted at Gaz de France have shown that Reinforced Earth® structures could withstand the drastic impact of a fire following the leakage and ignition of a cryogenic fluid. The thermal resistance of Reinforced Earth® as a construction material has been also proven in real situations such as the oil tank fire at Tacoa (Venezuela) and in addition it can be easily repaired after an accident.

Explosions

Experience has shown that the composite Reinforced Earth® soil mass is a highly stable explosion barrier that impedes the propagation of a blast at ground level and absorbs high levels of energy due to its tolerance for deformation. Because it is resistant to multiple fracturing, a Reinforced Earth® wall minimizes the dispersal of debris during an explosion. The positive results of early studies and experiments have subsequently been confirmed by the performance of structures in service.

Spills

Actual Reinforced Earth® structures have proven to be virtually impermeable despite the fact that they are composed of small, discontinuous elements. Combined with appropriate and adequate waterproofing, the Reinforced Earth® technique provides a convenient solution for the storage of waste outputs from industrial processes with a wide range of chemical aggressivity.

Mineral dust

With increased mining production capacity, live storage coal slot facilities were developed in the 70s and 80s using the Reinforced Earth® technique due to its flexibility and ease of construction. Large span roof structures covering these live coal storage facilities prevents dust migration and thus reduce the negative impact on health and environment.

Ammunition shelters (USA)

Trekkopje reservoir (Namibia)

Dorstfontein coal storage slot (South Africa)

Reinforced Earth® protective structures for risk mitigation

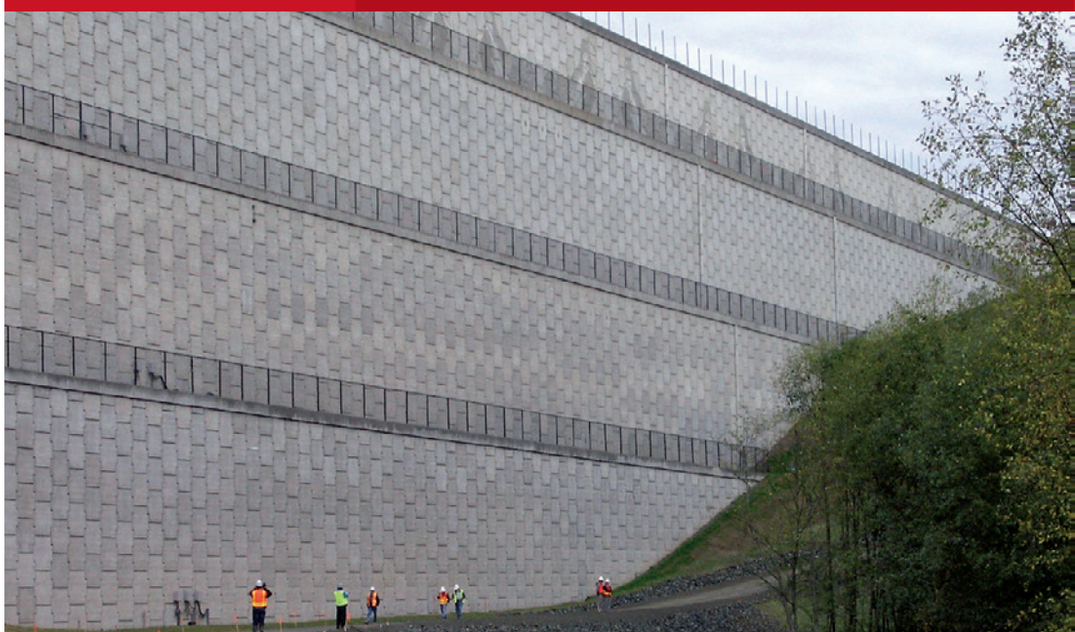
- Economy of materials
- Lower land use and site impact during construction
- Lower CO_2 impact than conventional solutions
- Use of natural or recycled materials
- Suitability of reinforcing materials to environmental and site conditions
- Durability
- Ease of inspection, maintenance and upgrading
- Ease of dismantling

Reinforced Earth®, the Value of Experience

When it was invented almost 50 years ago, nobody could foresee the great success of the Reinforced Earth® technique. It is now recognized as a major innovation in the field of civil engineering. The Reinforced Earth® method has widened its scope of applications to beyond just roads in the last 30 years, demonstrating its advantages in other markets. Reinforced Earth® structures have been designed and supplied by companies of the global network of Terre Armée Internationale for rivers and waterways applications.

Choosing a Reinforced Earth® solution allows owners and engineers to benefit from:

- the longest experience in the field of mechanically stabilized earth structures
- a global network of innovative companies deeply rooted in their markets
- tailored engineered solutions adapted to complex situations
- the widest range of reliable and sustainable materials
- a complete independence from manufacturers of reinforcing materials



Our goal is to create, design and supply innovative techniques to the civil engineering industry with a strong commitment to excellence in design, service and public welfare.

Sustainable Technology

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Publication: 11/2016 - Printed in France