



GEOQUEST

Ports & Harbours

REINFORCED EARTH® APPLICATIONS FOR HYDRAULIC WORKS



Swansea - United Kingdom

Reinforced Earth® and the sea

Our Reinforced Earth® technique has been used for over 45 years to construct marine structures along coastlines and within harbours. In these environments, design and material selection must account for the unique challenges and risks posed by marine conditions. The proven performance characteristics that have made Reinforced Earth® widely accepted in traditional civil engineering can be seamlessly adapted to meet the specific demands of marine projects.

Marine structures are **intermittently or continuously exposed to seawater**. Our walls consist of high tenacity polymeric soil reinforcements in combination with non-metallic connections, which are set into the concrete facing panels, producing a system that is corrosion free and perfectly adapted to the seawater environment.

Geoquest's marine structures are designed and built **to resist the combined forces of water and waterborne debris** which can be highly destructive during storms, as well as other environmental stresses such as **waves** or **driven pack ice**. Structures often include **panels designed for functional requirements such as wave deflectors**.

Reinforced Earth® panels, when combined with appropriate backfill materials, **provide adequate drainage**, especially in structures exposed to high tidal amplitudes or storm surges.



Immingham Port - United Kingdom

Reinforced Earth® marine structures have generally been constructed under dry condition or during periods of low tides. Experience has proven that structures in sheltered sites or harbors can be submerged during the initial stages of construction without any damage to wall construction.

Our TechWall and T-Wall modular precast wall systems can **enable installation underwater with minimal disruption**.

Sea walls

Roads, motorways and railways, are often constructed along the seacoast just above the maximum high tide level. When the seacoast is so narrow that a new construction or widening of an existing communication link encroaches on the sea, retaining structures are required and the **Reinforced Earth® technique is perfectly adapted** to such applications.

Breakwaters and jetties

The inherent characteristic of resilience to dynamic loads makes Reinforced Earth® solutions particularly well suited for breakwater and jetty structures. As in traditional marine construction, and depending on the site conditions, the exposed side of these structures can be protected by rip rap, tetrapods or another appropriate solution.

Quays

Reinforced Earth® structures can be designed to **withstand the heavy loads** imposed by railway locomotives and goods wagons and the **stresses generated by bollards (mooring posts)** or other docking means. Thus the technique is particularly suitable for the construction of quays in commercial harbors.

Slipways and RoRo ramps

The advantageous properties of Reinforced Earth® system have also been used to build **ancillary harbour structures** such as **slipways, ferry Ro-Ro ramps** and **temporary special port structures**.

Marinas

The Reinforced Earth® method is well known to combine strong technical and operational benefits with aesthetic properties while providing speed of construction and substantial cost savings. Therefore it is an excellent solution for the construction of marinas, providing **the perfect answer to owners, local communities and users**.

Watertight marine structures

Our system can be combined with a **waterproofing membrane** to provide a patented watertight wall. This allows the use of Reinforced Earth® solution for structures which need to be **watertight** such as dry docks or protection levees against cyclonic storms or sea water surges.

TechWall™

Precast counterfort retaining walls

TechWall™ relies on counterforts, which play a crucial role in ensuring the overall stability and strength of the retaining wall. By acting as cantilever beams, the counterforts can effectively **resist the lateral earth pressure**, thereby reducing the moments in the facing panel. As a result, the thickness of the concrete panel can be **minimised**, without compromising the **strength and durability of the structure**.

TechWall™ can be used in a **wide range of hydraulic works**, like river channelings, **providing a cost-effective, reliable, and durable solution**.

COST EFFECTIVE

Lower overall cost compared to conventional methods, and minimal maintenance requirements

QUICK CONSTRUCTION

Standardised TechWall™ installation means underwater construction is possible

SUSTAINABLE

Thin panels allow for carbon footprint reduction

AESTHETIC

Various architectural finish options available



Dun Laoghaire Harbour breakwater project

As part of the ongoing development of Dun Laoghaire Harbour, a 430m long breakwater was required. During the project tender, the main contractor, Ascon Ltd, proposed an alternative design using the **Geoquest precast concrete panel system with geosynthetic soil reinforcements**. This innovative solution offered **significant cost savings** compared to the reinforced concrete caissons outlined in the original tender documents.

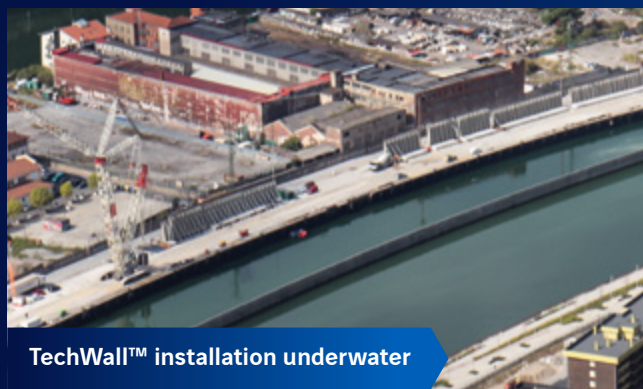
Construction began in the summer of 2000 after the completion of dredging works and the placement of the submerged rock fill core. By November 2000, the breakwater was substantially complete. The **construction process was carried out between tides**, starting from the shore and advancing into the harbour. This approach allowed all labor, materials, and equipment to travel along the partially completed breakwater, eliminating the need for expensive floating plant and **significantly reducing costs**.

The Geoquest breakwater was designed to withstand traffic loading, diurnal tidal variations, and substantial lateral wave forces from the specified design wave. By incorporating a synthetic soil reinforcement strip and connection system, the design also avoided potential corrosion issues, ensuring **long-term durability** in a harsh marine environment.

This project highlights the cost-effectiveness and reliability of Geoquest polymeric reinforcement systems for marine and coastal applications, showcasing their suitability for challenging environments.

Land reclamation using TechWall™

As part of a €20 million development, **50,000m² of land needed to be reclaimed** from within the Bilbao estuary. 750 TechWall™ units, each up to 10 m tall, were successfully **installed underwater**, forming the 1.5 km breakwater walls needed to contain the reclaimed area across two zones.



4044m²
wall area

4.6m
wall height

Hull Ferry Terminal

RoRo ramps for ferry boarding

At King George Docks, the P&O Rotterdam Ferry Terminal required a facility where vehicles could be loaded onto the upper deck of the ferry efficiently. A **RoRo ramp was required to enable vehicles to move** from ground level to the top level of the terminal building carpark and from there across a bridge to the ferry.

Geoquest designed and supplied the **Reinforced Earth® access ramp and abutment** to support a 45m single span bridge deck linking to the terminal building, the circular approach ramp was built to a very tight internal radius of 18m.

The ground beneath the ramp and abutment was poor and would be improved by provision of **band drains and controlled loading** (from phased construction of the Reinforced Earth® ramps). The ramp width was only 8m, hence the reinforcing strips overlapped with those from the opposite return wall, forming a **'back-to-back' MSE structure**.

After the walls were constructed, but before the parapet and surfacing were completed, a consolidation period began. Over approximately six months, the ramp structure's **foundation settled by nearly 500mm** at its highest point and almost zero at the bottom of the ramp. Considering the small footprint of the structure due to the tight curvature on plan, neither the walls nor abutment showed any signs of distress or facing panel displacements as a result of the differential settlement.

790m²
wall area

8m
wall height

This project demonstrates several key attributes of MSE walls over other retaining wall systems;

- › **Inherent flexibility** allowing substantial total and differential settlements to be tolerated without detrimental effect
- › The suitability of Reinforced Earth on **poor foundation soils** as the load from the coherent soil mass is **distributed over a wider area** than by other retaining solutions

Durable fabric-formed concrete solutions

We are proud to partner with Synthetex to offer HYDROTEX® fabric-formed concrete solutions for port and coastal applications. HYDROTEX® is a versatile system that involves **positioning geosynthetic fabric** forms over areas requiring protection and then pumping fine aggregate concrete into them, creating **durable linings suitable for both land and underwater installations**.

Enviromat® fabric formwork allows for the creation of concrete linings that can be **vegetated for a natural appearance** which is particularly suitable for revetments.

Our product offering also includes **grout bags, filter products** and **armour units**. Additionally, our pile jackets and pipe wraps are custom fitted to **protect oil/gas pipelines and undersea cables** against harsh marine environments.



Geoquest, the value of experience

- › **Suitability** of soil reinforcing and facing materials to environmental and site conditions
- › Structural **flexibility** on moderately compact or heterogeneous foundation soils
- › **Rapid construction**
- › **Reduced** land use and **site impact** during construction
- › Exceptional response to **wave impact**
- › **Lower CO₂ impact** than conventional techniques
- › Use of natural or **recycled materials**
- › **Ease** of inspection, maintenance and upgrading
- › Compatibility with internal **waterproofing** geomembranes
- › Durable for **120 years** in marine & brackish water environments

**Visit our website
to find out more**



 www.geoquest-group.co.uk

 info@geoquest-group.co.uk

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

