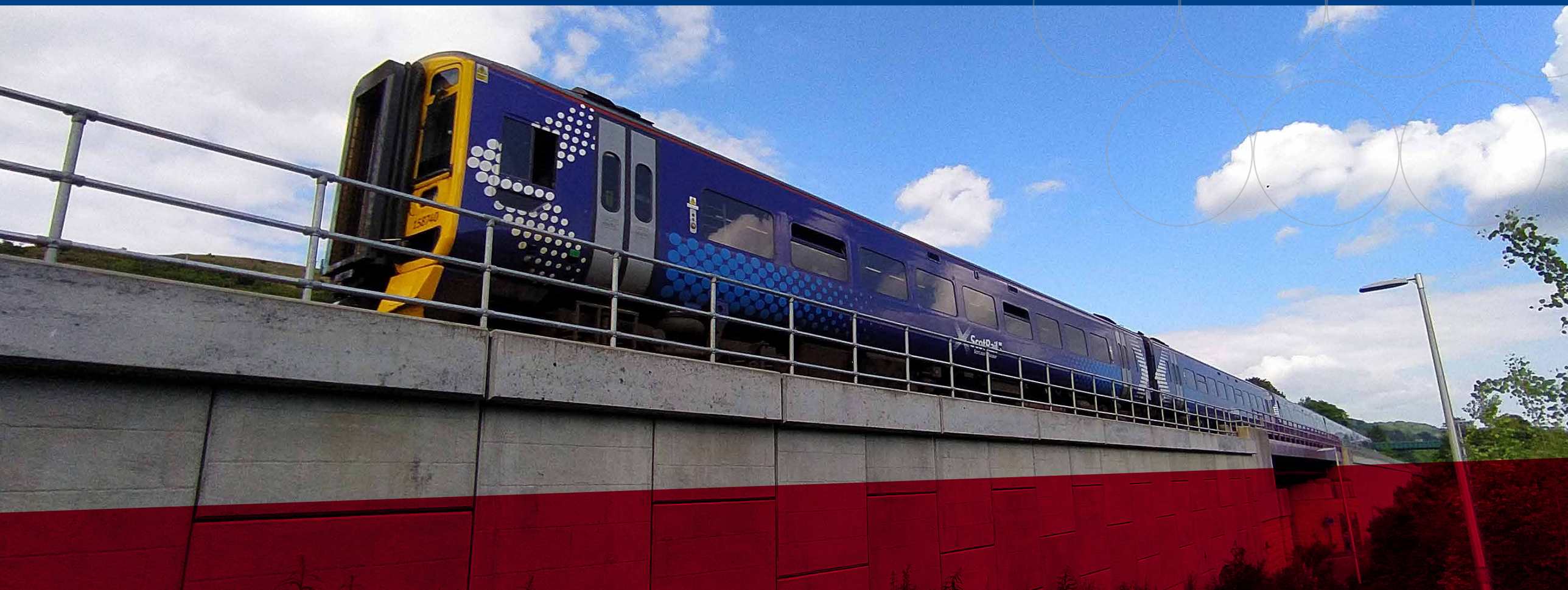
Borders Railway



REINFORCED EARTH
SUSTAINABLE TECHNOLOGY

A sustainable future.
For all your engineered soil solutions.

Client: **ScotRail**
Contractor: **BAM Nuttall**
Consultant: **Atkins**
Year: **2015**

26 Reinforced Earth® structures, **9,600 m² of retaining walls** of which 7 structures **and 5,000 m² of walls which directly support the rail lines.**

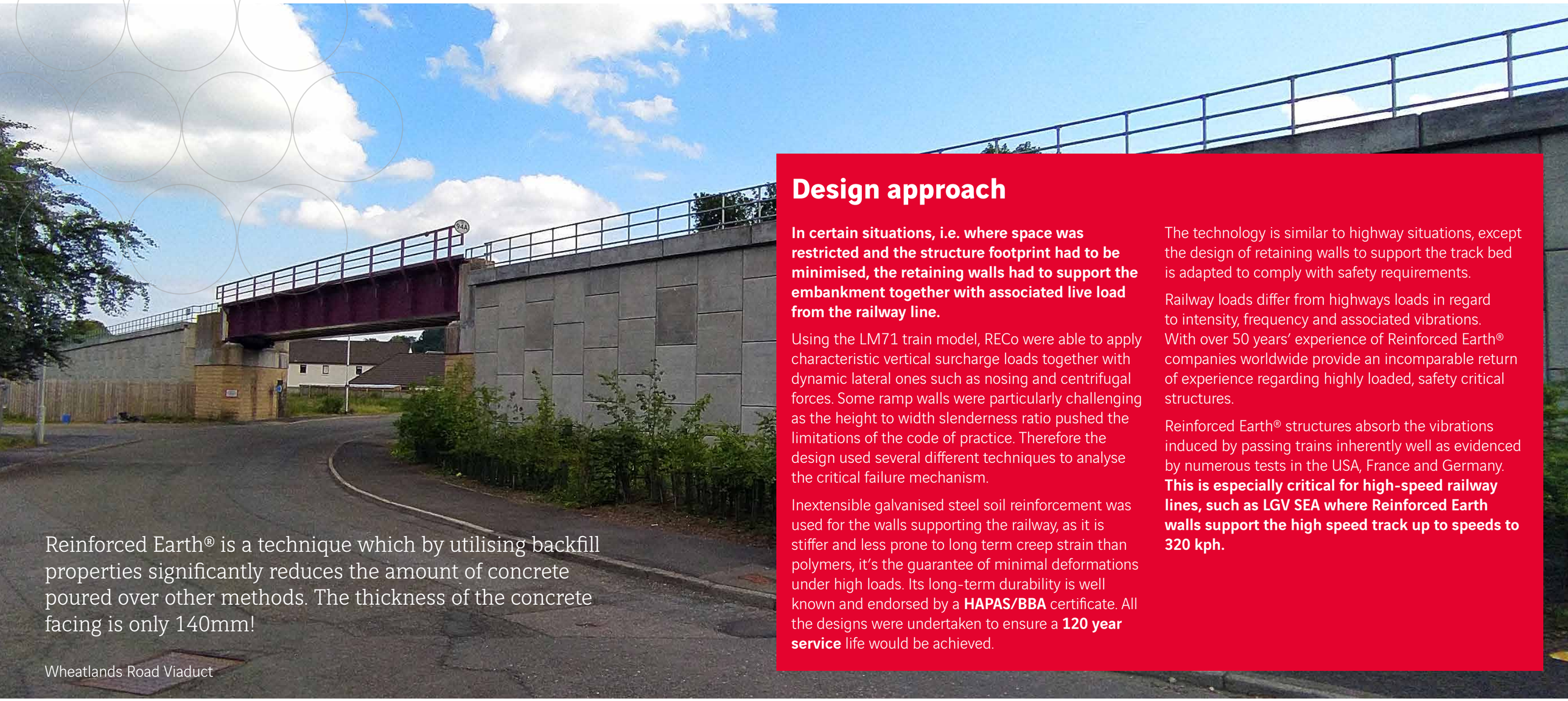
The Borders Railway is the longest new domestic railway to be built in the UK for over 100 years.

30 miles of track now provide a reliable transport connection between Edinburgh through the stunning Midlothian countryside to the borders town of Tweedbank.

Queen Elizabeth II opened the track in September 2015 before journeying on it in the Royal Train.

In 2016, Borders Railway was named the **Royal Institution of Chartered Surveyors' Scottish Infrastructure project of the year** for its delivery of essential facilities, services and infrastructure.

You can see a video describing the project in the below link **https://youtu.be/tW58INcvdi0**



Reinforced Earth® is a technique which by utilising backfill properties significantly reduces the amount of concrete poured over other methods. The thickness of the concrete facing is only 140mm!

Wheatlands Road Viaduct

Design approach

In certain situations, i.e. where space was restricted and the structure footprint had to be minimised, the retaining walls had to support the embankment together with associated live load from the railway line.

Using the LM71 train model, RECo were able to apply characteristic vertical surcharge loads together with dynamic lateral ones such as nosing and centrifugal forces. Some ramp walls were particularly challenging as the height to width slenderness ratio pushed the limitations of the code of practice. Therefore the design used several different techniques to analyse the critical failure mechanism.

Inextensible galvanised steel soil reinforcement was used for the walls supporting the railway, as it is stiffer and less prone to long term creep strain than polymers, it's the guarantee of minimal deformations under high loads. Its long-term durability is well known and endorsed by a **HAPAS/BBA** certificate. All the designs were undertaken to ensure a **120 year service** life would be achieved.

The technology is similar to highway situations, except the design of retaining walls to support the track bed is adapted to comply with safety requirements.

Railway loads differ from highways loads in regard to intensity, frequency and associated vibrations. With over 50 years' experience of Reinforced Earth® companies worldwide provide an incomparable return of experience regarding highly loaded, safety critical structures.

Reinforced Earth® structures absorb the vibrations induced by passing trains inherently well as evidenced by numerous tests in the USA, France and Germany. **This is especially critical for high-speed railway lines, such as LGV SEA where Reinforced Earth walls support the high speed track up to speeds to 320 kph.**

Overbridges

Along the route a number of road over rail bridges were required, this one for example connected the A7 to the village of Fountainhall.

Road bridges were designed using a normal traffic surcharge loading designed with GeoStrap®, soil reinforcement consisting of discrete channels of closely packed high tenacity polyester fibres encased in a polyethylene sheet. GeoStrap® is ideal for use in road applications as the fill used around the strips has no limitation to its salt content.

What's Reinforced Earth?

Reinforced Earth® is a composite material made from frictional fill and soil reinforcement that combined together are capable of bearing high tensile stresses. When pressure is applied it causes a strain in the soil that will transmit tensile load to the reinforcements. Movement is resisted in the direction of the soil reinforcement causing the whole mass of fill to behave as a coherent gravity block. In short, Reinforced Earth® is a system which enhances the shear strength of the fill enabling it to be used to support high loads.

A7 to the village of Fountainhall

GeoStrap® is ideal for use in road applications as the fill used around the strips has no limitation to its salt content.

Underbridges

In places, the new railway line had to cross existing roads or watercourses. It was important that there was as little disruption to traffic or ecology as possible, a typical example of which is shown below.

In addition to its primary advantages of load bearing capacity, resilience, economy and speed of construction, Reinforced Earth structures require little space to be constructed. Structures are not deeply founded, require no footing beyond the front face and as a result excavation is kept to a minimum.

Reinforced Earth® structures absorb the vibrations induced by passing trains inherently well. This is especially critical for high-speed railway lines.

Railway flyovers –
walls supporting the tracks

Some of the most challenging and significant structures were needed in built up areas where the railway had to span highway intersections, usually in the form of a ramp supporting the rail track.

To minimise the land take and materials, the ramp width was relatively narrow when compared to the overall structure height.

This height to width ratio together with the various loading models was carefully analysed by Reinforced Earth Company designers to ensure the overall stability of the structure was not compromised.

Reinforced Earth® ramps reduce highly concentrated superstructure loads to acceptable uniform bearing pressures at the foundation level. This can often eliminate the need for piling or other costly and intrusive foundation improvements.

Engineers have been using steel soil reinforcement to support highly concentrated loads from our first walls supporting railways back in 1973 to the present. The inextensible nature of steel was critical in their selection for these types of walls where it is paramount that the performance of the structure is maintained over its intended lifespan.

Sustainability

With cement, aggregate sand and water all becoming pressurised resources, **Reinforced Earth® is a technique which by utilising backfill properties significantly reduces the amount of concrete poured over other methods. The thickness of the concrete facing is only 140mm!** On this project all the concrete for our walls was manufactured with either a blend of recycled PFA (pulverised fuel ash) or GGBS (Ground Granulated Blast-furnace Slag), further reducing our embodied carbon associated with concrete by 30%.

Hardengreen Viaduct

Footbridges

Old Craighill Road – Millerhill, a little south of Edinburgh, a new footbridge was required for pedestrians to safely cross over the new rail line.

The ramps leading to the bridge were formed from GeoStrap® polymeric soil reinforcement directly connected to a robust galvanised wire mesh face. Stone was placed in a 300mm zone behind the facing mesh to form a gabion style appearance.

All the designs were undertaken to ensure a 120 year service life would be achieved.

Reinforced Earth Company

Reinforced Earth Company were asked to provide our specialist technical services to undertake the design of 26 separate structures, using a combination of products and techniques developed by our group. Working together with our supply partners we also delivered around 9,000 sqm of precast concrete faced walls.

When it was invented over 50 years ago nobody could foresee the great success of the Reinforced Earth® technique. It is now recognised as a major innovation in the field of civil engineering.

The Reinforced Earth® method has substantially widened its scope of applications beyond just roads in the last few decades, demonstrating its advantages in other markets. Structures associated with railway projects have been designed and supplied by our group on five continents since 1973.

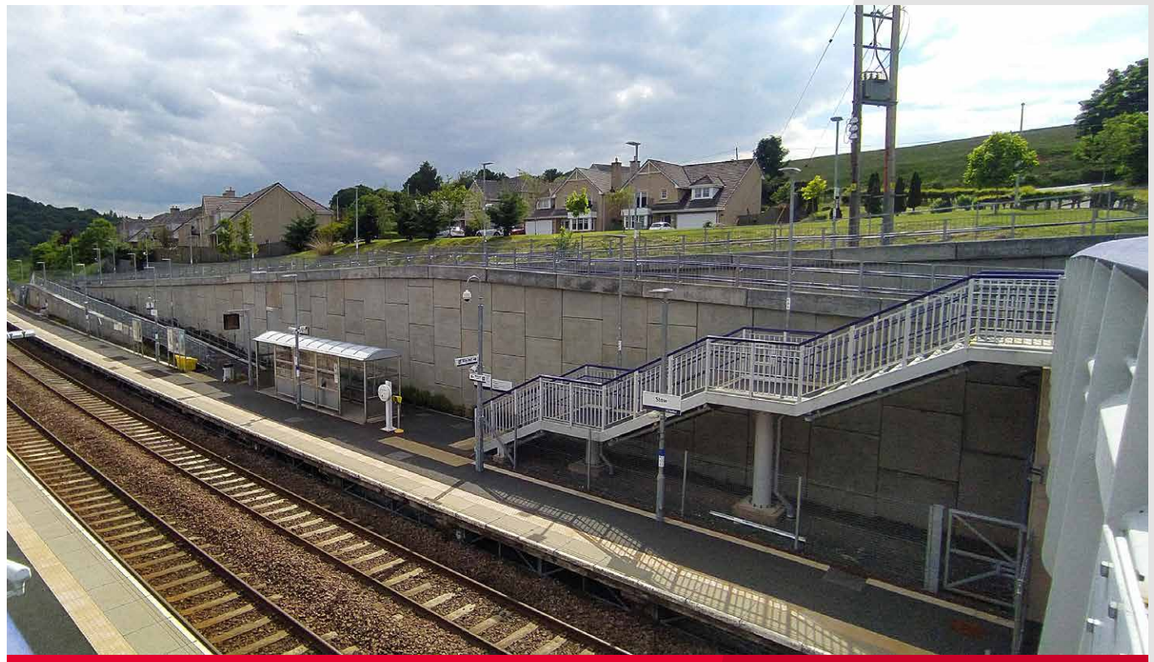
Old Craighill Road – Millerhill

Stations

Stow is a peaceful village and one of the stops on the Borders Rail line.

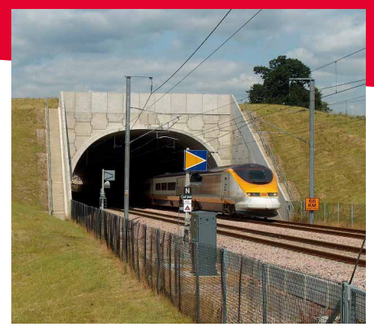
Retaining walls were required to form pedestrian ramps giving easy access to the station platforms and to the footbridge crossing the line. The ramps leading to the footbridge were formed from **GeoStrap® polymeric soil reinforcement** directly connected to precast concrete facing panels. The installation of Reinforced Earth® is essentially an earthworks operation. As the components which make up the wall (facing, soil reinforcement) are prefabricated means you only need to bring in the supply of the elements required to build that section at a time.

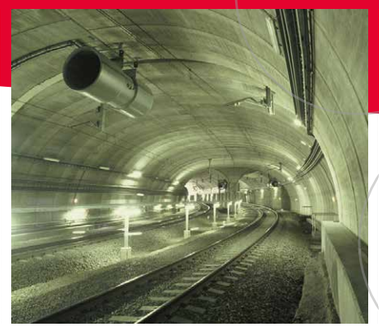
The walls are installed without the need for complex support or scaffolding and are constructed entirely from the rear face, making it ideal for restricted spaces.



Stow Rail Station

For all your rail needs





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BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE 12/H182

BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE 18/H276