

RETAINING STRUCTURES

- Gravity retaining walls
- Reinforced soil slopes and structures
- Design, supply and installation

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Phi Group is the UK's largest retaining structures specialist, providing clients with the full design, supply and installation service.

We have continuously balanced engineering demands with environmental considerations to ensure we offer the most economically viable solution, not just from a retaining structures perspective, but the overall whole life project costs and safety. We are solutions led, not product led, so will therefore work to provide the most appropriate solution to your retaining and slope stabilisation needs.

Phi Group designs and installs over 300 retaining walls every year in a challenging and demanding field of construction, using our wide range of bespoke solutions. We are extremely proud of our track record, from a quality, service and continued H&S perspective.

Being part of the Keller Group of companies has helped reinforce our position as the market leader, utilising the financial security, engineering skills and technical knowledge, that being part of the world's largest independent geotechnical contractor brings. Keller's philosophy of global strength and local focus, ensure we give our customers cost effective and innovative solutions of the highest quality.

Julian Fletcher, Managing Director

SOLUTIONS

REINFORCED SOIL SLOPES

Reinforced soil slopes and structures are typically used where levels are being raised on site, and steep slopes or vertical structures are required, therefore increasing the amount of flat available land to develop. Material is compacted around layers of reinforcement to form a reinforced soil mass. The facing is then chosen based on slope angle, maintenance and aesthetic considerations.



TEXTOMUR

Green Faced

Textomur consists of horizontal geogrids or geotextiles typically at 600mm vertical centres within compacted cohesive or granular fill material. The facing to the slope is formed using a steel mesh 'formwork' backed by a geosynthetic facing fabric, which retains a layer of topsoil immediately behind the face. Slopes up to 65° are suitable for the establishment of vegetation, but various factors such as aspect and how much water the slope will get all need to be considered.

Stone Faced

We will design Textomur with a slope angle up to 70°, but will recommend the use of gabion style finish to the front face. This is because the chance of long term growth diminishes the steeper the slope becomes. Where we are installing a stone faced finish, we will galvanise the Textomur cages and use a mesh with smaller aperture size. This has the added benefit of providing a maintenance free solution.

- The ability to re-use selected site won material as the RS fill material
- Generates potential savings on both cart away and the import of material
- Quick to construct with no structural foundation required
- Various face angles achievable depending on space available
- Construction carried out from behind the wall so can be built on the boundary
- Designed, supplied and installed by one contractor



REINFORCED SOIL STRUCTURES

Vertical reinforced soil structures use a variety of reinforcing elements such as geogrid, steel ladders or polymer and steel straps. A variety of facing elements are available with modular block and concrete panels being the most popular.



MODULAR BLOCK REINFORCED SOIL

Concrete modular blocks are a popular facing for reinforced soil structures. They offer a high quality split face architectural finish, whilst also ensuring a maintenance free design life of 120 years. Phi Group's Titan system utilises galvanised steel ladder reinforcement at specified horizontal and vertical centres, as opposed to geogrid. This makes possible services and drainage to the rear of the structure easier to accommodate. It has BBA HAPAS Certification, which means it is suitable for use on highways and infrastructure schemes. Due to the architectural finish of the system, we have also used this system on many residential, education and commercial projects, as well as major infrastructure projects.

A well graded imported stone, similar to 6l/6J, is typically imported to form the reinforced soil mass when constructing vertical reinforced soil structures with a modular block or concrete panel facing. This means the use of site won material is not usually an option as it is with the reinforced soil slopes.

- Quick to construct
- Durable
- A variety of colours available
- Immediately serviceable once constructed

Phi Group can design, supply and install a variety of reinforced soil structures other than our Titan system, so are flexible depending on the Client's requirements. We also provide an installation only service for concrete panel and modular block reinforced soil systems that have been designed and supplied by others, with numerous prestigious projects completed in recent years.



SOLUTIONS

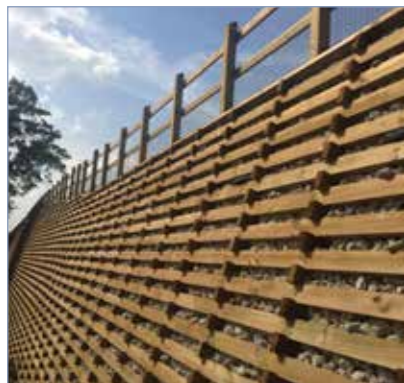


GRAVITY RETAINING WALLS

Gravity retaining walls use the mass within the structure to resist the applied forces from the ground behind. Typically used in a cut situation, they are predominantly installed leaning back at an angle so are less imposing than a vertical structure.

GRAVITY RETAINING WALLS

There are a wide range of gravity retaining wall solutions available, with cost, aesthetics and design life, all a consideration.



PERMACRIB TIMBER CRIB

Permacrib is our patented timber crib retaining system, used successfully within the UK for more than 30 years. Permacrib's lightweight timber components are used to create a timber cage that is filled with a 75mm-40mm clean stone. It is machined and treated in the UK, using PEFC Certified timber, so a full chain of custody is available. The sustainability credentials of the Permacrib system is just one of the many benefits this flexible solution offers.

- Certification - Only timber crib system to have BBA Certification.
- Durable - 60-year design service life
- Very quick to construct
- Installed at a 4V:1H (76°) batter so less impact than a vertical structure
- Landscaping of the front face an option using planting bags
- Flexible design and construction, with corners and curves easy to achieve
- Used over a wide variety of market sectors such as residential and commercial



GABION BASKETS

Gabions are rectangular baskets formed from steel mesh, which are then filled with a large angular stone, typically 100-200mm in size to give the required mass. The mesh used can be either welded or woven, with the former offering a more rigid front face. The cost of gabions is dependent on the cost and availability of the infill stone. The density of the gabion infill stone is lower than the crib wall infill, so the structure depth will need to be greater. The use of gabions as an architectural facing to buildings and for free standing walls, is an application that is becoming more popular, and we have experience in.

- Infill stone is hand placed at the front face to give a more architectural finish
- Ideal for use where water may be an issue such as balancing ponds
- Can be built off a compacted granular foundation
- Installed at a batter, or with a 150mm step after each gabion course
- Design life from 30 to 120 years depending on mesh thickness and treatment
- Regional cost differences can occur due to infill stone cost



ANDACRIB CONCRETE CRIB

Andacrib is our robust concrete crib retaining wall system, with a proven track record on a wide range of projects. Andacrib's unique design has header to header bearing pads, that ensures primary loads are not on the front face. Developed for use in the harshest of environments, all of the concrete components are machine placed and filled with a 75mm graded stone to give the required mass.

- 120-year maintenance free design life so ideal for infrastructure projects
- Landscaping of the front face an option using planting bags
- Very quick to construct
- Installed at a 6V:1H (80.5°) batter



ADDITIONAL SOLUTIONS

Phi Group can also offer a design, supply and installation service for L-shaped concrete panel walls, where the construction depth of our other systems may mean they cannot be accommodated. Quick to install and readily available in standard sizes from 1.0m to 3.75m, this system can be installed quickly.

Our sister company Keller offers a supply and installation service for King Post retaining walls and quite often we are working on the same projects providing various retaining solutions.

SAINSBURY'S DISTRIBUTION WAREHOUSE, DAVENTRY

Prologis contracted Volker Fitzpatrick to construct a large distribution warehouse at the Daventry International Rail Terminal.

With over 1,000,000m³ capacity, the warehouse is served by a new rail head. To facilitate this, a new earth bund needed to be constructed as the levels on the new site were some 9.0m lower than the site next to it.

Phi Group became involved at an early stage to work with

VFL and their consultants to ensure the most buildable and economic solution was proposed. This is one of the larger contracts that Phi Group have undertaken with a value of £2.3million.

It highlights the resource levels that we have available to be able to undertake a project this size, in addition to the many other projects that we undertake every year.

The main structure is a 70° Textomur reinforced soil slope,

PRODUCTS USED

- 70° Stone Faced Textomur Reinforced Soil
- 45° Reinforced Soil Slope
- Concrete Panel Faced Reinforced Soil Structure
- Andacrib Concrete Crib Wall

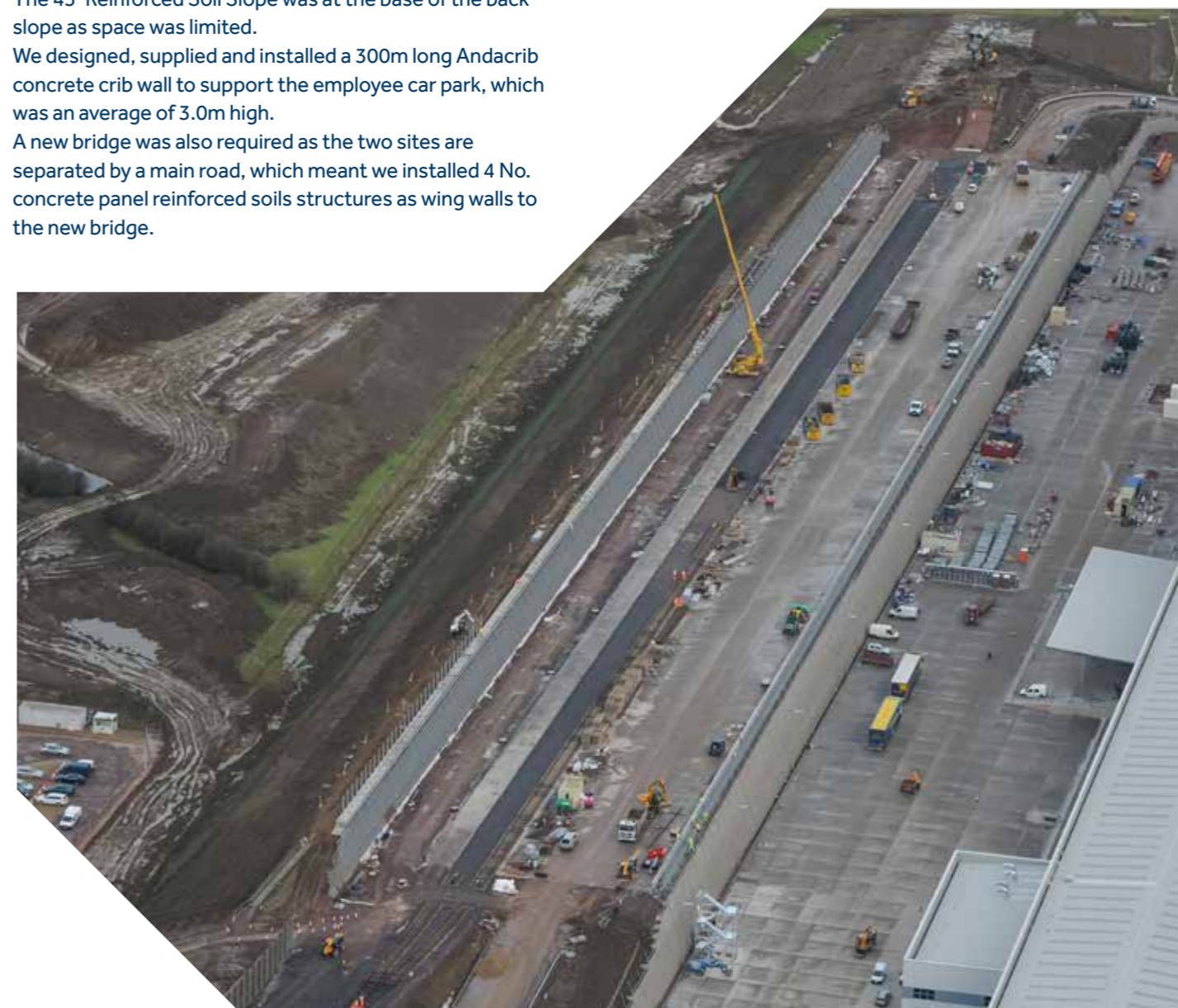
that was formed using a site won lime stabilised clay material. This offered a substantial cost saving on the original solution proposed, removing the need to import or cart away material.

The lower structure was 9.0m high and supported the concrete service yard and new rail tracks. Above that was another 5.0m Textomur structure to ensure the warehouse was hidden from a future housing development.

The 45° Reinforced Soil Slope was at the base of the back slope as space was limited.

We designed, supplied and installed a 300m long Andacrib concrete crib wall to support the employee car park, which was an average of 3.0m high.

A new bridge was also required as the two sites are separated by a main road, which meant we installed 4 No. concrete panel reinforced soils structures as wing walls to the new bridge.



PRODUCTS USED

- Andacrib Concrete Crib Walls
- Permacrib Timber Crib Walls
- King Post Retaining Walls

WADHURST PLACE, SUSSEX

Newcourt Residential contacted Phi Group when they redeveloped the former Wadhurst College for residential use.

This 18-acre site presented some unique geotechnical challenges as it is sloping with historic slips.

The first retaining wall constructed was a Permacrib timber crib wall, which was installed to provide additional parking spaces.

Off the back of this initial contract, Newcourt engaged

Phi Group to design various retaining walls over the rest of the site, with an additional three Permacrib timber crib walls installed at various locations.

The pleasing aesthetic appearance of the Permacrib makes it ideal for use in residential situations. Where space constraints meant the Permacrib structure depth could not be accommodated, our colleagues at Keller were contracted to install a King Post retaining wall, which butted into our Permacrib wall.

The Permacrib walls are up to 5.0m in height and various angle changes employed, highlighting the flexibility of the Permacrib system.

The third and fourth walls constructed are the largest on site so far, and presented quite an engineering challenge for both Phi and Newcourt.

The terraced walls support two plots above with a road below. The site conditions largely comprise of poor quality Alluvium overlying the Wadhurst Clay formation. Between Phi Group, Newcourt and their geotechnical engineers GCG, a system of counterfort drains were designed and installed to mitigate this risk.

From a geotechnical, cost and aesthetic perspective, our Andacrib concrete crib was chosen.

We incorporated planting bags within the Andacrib, so vegetation will be able to establish, and in time hide the structure from view.

The Andacrib system is a robust solution with 120-year

design life, so will provide maintenance free retention for years to come.

The two tiered walls retain over 14.0m in height and have a length of over 200.0m.

The face area for both walls is close to 1,000m².



- Gabion Retaining Walls

HORFIELD CUTTING, BRISTOL

The Great Western Route is undergoing a period of modernisation with the upgrading of infrastructure to make journeys faster and services more reliable. Part of this scheme is the Horfield Cutting where an extra lane is being added to ease a bottleneck in the rail system.

MJ Church, the civils contractor for Main Contractor Vinci Construction, contracted Phi Group to install a gabion retaining wall nearly 1,000m long and up to 5.0m high in places. Working on a railway presents unique challenges and safe working is the main priority.



Communication with all parties involved is key with access to bring materials to the working area the governing factor on whether programme can be achieved.

Woven mesh gabion baskets were originally specified by the client, but Phi Group proposed they be changed to the welded mesh gabion baskets that are quicker to install, as the more rigid nature of the welded mesh makes them easier to work with.

The baskets are then filled with 6G gabion stone to give them the required mass. Then uPVC sleeves were incorporated within the baskets as they were being built, so soil nails could be installed through the

baskets to further stabilise the slope once the gabions were finished.

Hand placing of the gabion stone to the front face ensures a great looking finish to the gabion wall.



PRODUCT USED

- Textomur Reinforced Soil Slope
- Concrete Panel Faced Reinforced Soil Structure

A465 HEADS OF THE VALLEY

We are extremely proud of the work we are doing with Costain on Section 2 of the A465 Heads of the Valleys Dualling project.

We are currently on site carrying out the installation of several of our Textomur green faced reinforced soil slopes. Phi Group were employed at an early stage by Costain to work with their designers Atkins/

CH2M Hill to provide detailed design input for many structures required on this section of the project.

Having a specialist on board meant that design issues were addressed as the scheme was developed, prior to actually commencing on site, so any design related delays were minimised.

This collaborative approach is working extremely

well, and will ultimately facilitate savings in both programme and costs.

We commenced on site in early 2017, and at present have built 15 slopes, with several more Textomur slopes to be built during 2018.

As well as building our own Textomur system we have also provided labour and plant to construct a substantial concrete panel reinforced soil structure for Costain.

All of the structures are substantial, as can be seen from the photographs, with the largest structure 14m high.

We have an ever-expanding workforce present on site

to make sure that we complete the works safely and on programme, with 50 operatives on site at peak periods.

Phi Group again providing the complete design, supply and installation package.



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