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GEOSYNTHETICS

NEW KID ON THE BLOCK

Chepstow gets the first UK use of a system for a large reinforced soil wall. Laurence Tomlin and Peter Assinder report.

Chepstow is the first place you arrive at in Wales when crossing the River Severn suspension bridge. And the town in the country's south has just seen the completion of the first use of the Allan Block facing system (see box) for a very large reinforced soil wall.

The £750,000 reinforced soil solution comprises a wall built at 84° to the horizontal, ranging in height between 3m and 9m and being over 700m long.

It is located on the site of two large retail distribution warehouses, which originally comprised open fields generally sloping gently down from north to south. The elevation ranges between about 12m OD and 20m OD. The proposed development necessitated the formation of a level building platform on the site, resulting in the need for a substantial ground retaining system around the north part.

A planning requirement was to ensure that the roof ridgeline of the portal-framed buildings was screened by an earthworks bund with a crest level of 22m OD.

As the north part of the site had to be retained as steeply as possible to maximise the area available for development, several options of retaining structure were considered. These included crib walling, gabion walls and reinforced earth walls.

Peter Brett Associates (PBA) undertook a preliminary assessment of the reinforced soil options in association with Huesker. It was decided that it would be possible to use site-won bulk earthworks material for construction within a reinforced soil segmental block retaining wall.

Main contractor Winvic instructed PBA to progress with the detailed design of the reinforced soil structure and PBA associate Laurence Tomlin led the design team. The main challenges faced were ensuring that the earthwork materials would provide a suitable and acceptable fill material to be used within the reinforced soil construction.

The geology beneath the site consists of a typical weathered profile of the Mercia Mudstone Group of the Triassic Period and excavated deposits of the Mercia Mudstone, which were used within the retaining wall construction. In terms of the Department for Transport Specification for Highway Works (SHW) these materials would generally fall within a Class 7C wet cohesive fill for reinforced soil.

Not using the clays and mudstones would have had a significant impact on the cost of the works, particularly because the very large geometry of the reinforced soil wall would have required an extensive amount of imported fill.

Large diameter shear box tests were undertaken on samples of the clay and mudstone fill to confirm the adopted design parameters for these materials. Results showed that the drained angle of friction for the fill was likely to be well in excess of the parameters used in the design. PBA produced site-specific criteria to ensure that the materials were suitable.

Winvic Construction undertook the main site development with J&H Construction building the reinforced soil wall. The geogrids used within the wall were Fortrac, manufactured by Huesker. The ultimate tensile strengths of these ranged from 110kN/m to 35kN/m.

The design was in accordance with *BS8006:1995 Strengthened / Reinforced Soils and Other Fills*. A check on the design was also done using Allan Block's own in-house software, which is generally based on US standards, particularly *FHWA NHI-00-043 Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guide Lines, 2001*.

Although there are some differences between US methods and designs based on British standards, there was a reasonable agreement between the outputs for each method. Further checks were done by engineers from Allan Block, based in the firm's head office in Minnesota, US.

The design process included calculation of the required geogrid block connection capacity. Because of the height of the wall at some points, high connection capacities were required. Huesker undertook

Fortrac geogrids were used within the wall

Scaffolding attached to the facing units provided a safety rail

The wall is 3m to 9m high and 700m long

testing of connection capacities in the US and the results were used in the design – where the connection strength was the controlling strength over the geogrid design strength.

Construction of the reinforced earth wall began last autumn and completed in the spring – probably not the ideal time of the year for controlling earthworks in a structure of this kind.

During building there were periods of significant rainfall that caused problems controlling surface water, which tended to flow over the surface of the fill behind the wall. This not only impacted on the fill quality but also flowed over the face of the wall.

To protect the fill quality and mitigate any potential problems with compaction and the resulting need to remove unacceptable fill, no earthworks were done when there was any risk of such rainfall.

Once the site bulk earthworks were completed, a Class 803 Type 1 fill was placed along the proposed line of the reinforced soil wall to produce a level foundation for the first row of Allan Blocks. It was important to ensure that the foundation was level and within tight tolerances, particularly in view of the length and height of the structure, so there would be no unsightly variations in the block coursing.

The specification for the construction of the reinforced earth wall included acceptance criteria based on moisture content and end-product insitu density. In addition, the method of compaction was also specified based on the guidance in SHW. Compaction specified was for four passes of a Bomag 120 roller for a layer thickness no greater than 175mm for the bulk fill away from the face of the reinforced soil block. Close to the face, a plate compactor was used so as not to affect the face blocks.

During construction the moisture content of the fill material at source was determined on site using a microwave method. Although there may be some variability, the test is considered to give results that are within about ± 2% of the moisture content. It therefore gives a reasonable level of confidence that the material to be included in the earthworks is likely to be within acceptance criteria before it is placed.

When results indicated that the moisture content was likely to be outside acceptance limits, the earthworks were either put on hold until the fill material became acceptable or an alternative source was identified that was within acceptance limits.

In addition to site determinations of moisture content, the in-situ dry density and moisture content were determined at a frequency of one per 500m^3. A nuclear density meter was used, which was calibrated against sand replacement tests every 10 tests. When the results of either the site moisture content tests or the in-situ testing indicated that the fill material fell outside the tolerances of the specification, it was scarified in-situ or removed for drying ex-situ before re-use.

Immediately at the rear of the block facing units, a minimum 300mm of free draining fill, comprising Class 6N, was placed to mitigate the potential for water pressure build up immediately at the rear of the segmental block.

As the reinforced soil block wall was constructed there was a need to provide an adequate safety rail along the face. Several options were considered but eventually scaffolding was attached to the facing units using expanding anchors drilled intermittently into the blocks.

To assist in the early stages of construction, Allan Block provided an engineer to aid the contractor in the best methods of constructing the reinforced soil block facing system. On-site advice was also provided by Huesker for the geogrid reinforcement within the wall.

Internal and external radiuses were easily constructed, and tighter radiuses were achieved by simply chipping off the internal wings of the block.

Laurence Tomlin is an associate with Peter Brett Associates and Peter Assinder is an applications engineer with Huesker.

How the system works

The Allan Block system is a hollow, dry-laid block with a free draining angular stone placed in the hollow part of the block. There is no positive locking connection system between the geogrid and facing block. Consequently, the pull-out resistance for the geogrid relies on frictional resistance between the grid, block and the granular infill. This type of system has been used extensively in the US for numerous large reinforced soil walls, but had not been used on any major reinforced soil walls within the UK.

A Bomag 120 roller made four passes over layers with a 175mm maximum thickness

Elevation ranged from 12m OD to 20m OD