CASE STUDY

DIAPHRAGM CONTAINMENT WALLS USING PFA AT BEDFONT LAKES, MIDDLESEX

Bedfont Lakes, lying half a mile south of Terminal 4 of Heathrow Airport, is a 250 acre development undertaken by the Rutland Group, providing commercial office space in a unique parkland environment.

The south side was originally used to extract gravel for aggregates and was subsequently used as a landfill site for household and other waste material. Permission was granted to develop a business park, light industrial premises, housing, car parking and a large public park on the 100 hectare site. The scheme included the reclamation and landscaping of much of the site and the construction of an artificial lake.

To isolate the areas for industrial use and adjoining residential housing from pollution by leachates and landfill gas, it was decided to install a diaphragm containment wall which would surround the southern part of the site, and in conjunction with clay capping and venting trenches, would provide long-term containment of the pollutants present in the landfill.

The scheme

A contract was awarded to provide a slurry wall excavated to an average depth of 8m below the existing ground level. The specification called for a 500mm wide trench to be constructed using a self hardening material that would remain impermeable to water even if small ground movements occurred following construction of the wall.

Much of the slurry wall was constructed within the remaining granular deposits at the site boundary. However, some sections were excavated within the refuse and other waste products which had been tipped over a number of years. To form an impermeable barrier, the slurry wall penetrates into the underlying London Clay beneath the landfill. Both the natural and landfill materials, through which excavation took place, proved to be very variable in strength and porosity. Groundwater was encountered about 2m below the working surface. Conventional rigid retaining walls are inappropriate for applications such as these because they are usually too permeable and, also, too stiff to ensure similar deformation to the surrounding ground, the absence of which would create uncontrolled passages for gas and leachate escape.

The contractor was therefore faced with designing a self-hardening slurry to meet several conflicting parameters:

- to have an in-situ permeability not greater than 1 ¥ 10m-9 m/s once complete
- to have a compressive strength not greater than 1.5 N/mm^2 at 28 days age
- to be able to withstand a strain of 5% without failure by cracking, at 90 days age
- to have sufficient density and filter caking ability to provide stability to the trench during excavation
- to have sufficient durability to withstand attack from the chemicals present in the landfill.

Selected method

Trial mixes were carried out by the contractor to select a mix to meet the specified criteria and have suitable rheological properties to ensure pumpability and trench stability. The mix selected was a compilation of Bentonite, OPC and Pulverised Fuel Ash (PFA). The trials indicated that that the material hardened to the consistency of a stiff clay in about twelve hours, and that strength gain and consequent reduction in permeability continued for about 90 days.

A sophisticated computer controlled batching plant was erected on-site providing storage for bulk deliveries of dry materials and capacity to allow hydration of the bentonite mud prior to addition of the OPC and PFA. The plant was capable of producing 220m^3 of slurry per shift.

RWE
The energy to lead

The wall was constructed in a continuous trench, each day's work being overlapped into the previous day's semi-hardened slurry to ensure continuity at day joints. Any reduction in the level of the slurry, which occurred overnight due to bleed or shrinkage, was topped up the following day.

A Fiat Hitachi excavator with extended dipper arm and 600mm digging bucket was used to construct the trench. During the work, the underlying clay was found to be deeper than indicated by the site investigation and, therefore, the excavator boom was extended to allow a maximum excavation depth of 11m. Each day, a short length of trench approximately 1m deep was excavated, and then filled with freshly batched slurry.

Excavation then continued through the slurry which provided support to the trench, and as spoil was removed from the excavation, further slurry was added to maintain its level. Once the underlying clay was reached and the required 0.5m penetration achieved, the excavation was extended along the required line. Up to 40 linear metres of wall averaging 8m depth was constructed each day.

Samples of slurry were taken from the trench and poured into moulds, where they were allowed to harden prior to their despatch to a laboratory for testing. The very high water content of the mix made it essential to ensure that both the samples and the in-situ wall were protected to avoid moisture loss, which would cause drying and cracking of the material. The samples were waxed and capped. The in-situ wall, once hardened, was temporarily protected with excavated spoil.

After completion of the slurry wall, a venting trench was constructed 3m inside and parallel to the former. This comprised a series of 225mm diameter stone filled bores, spaced at 3m centres. Extending to beneath the existing water table connected by a 3m deep stone filled trench, which continued to provide a means of ventilation for landfill gas. Both the slurry wall and the venting trench were subsequently capped with a 0.5m thick clay layer which provided protection.

Venting pipes passing through the capping allow the gas to be vented from the granular trench in a controlled manner.

Why PFA?

The use of PFA in the mix design resulted in three major advantages:

- it enabled the wall to meet the required impermeability without exceeding the specified compressive strength (partial replacement of cement by PFA produces a lower strength mix without increasing permeability, as the particle size of the two materials is comparable)

- it enabled the wall to achieve the specified strain capability
- the spherical nature of the PFA particles increased the lubrication of the mix enabling the slurry to be pumped over a distance in excess of 1km.

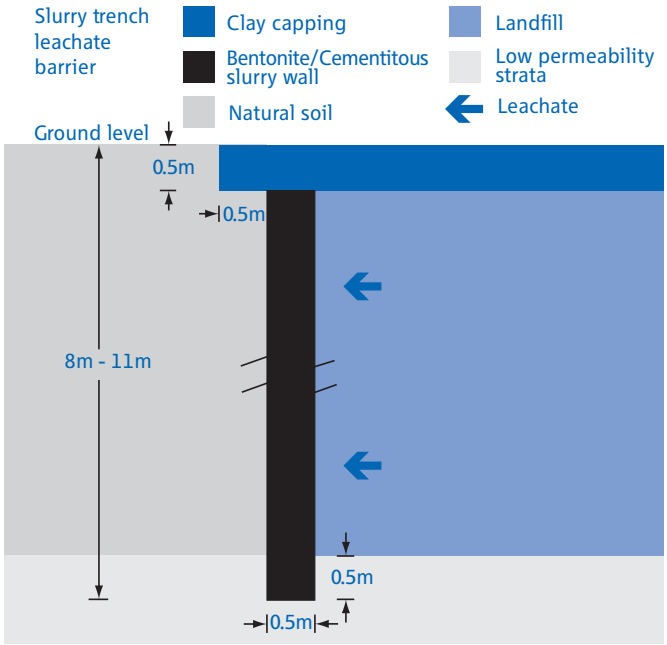
Acknowledgments

Developers:
The Rutland Group

Consulting Engineer:
W A Fairhurst and Partners

Main Contractor for infrastructure works:
Fairclough Civil Engineering Ltd

Specialist Geotechnical Sub-contractor:
Fairclough Piling



RWE Power International

Generation Aggregates
Electron
Windmill Hill Business Park
Whitehill Way, Swindon
Wiltshire SN5 6PB
United Kingdom

T +44 (0)800 731 2865
F +44 (0)1793 892421
E generation.aggregates@rwenpower.com
I www.generationaggregates.com

Registered office:

RWE Npower plc
Windmill Hill Business Park
Whitehill Way, Swindon
Wiltshire SN5 6PB

Registered in England and Wales no. 3892782