

PILING AND FOUNDATIONS: DEEPHAMS SEWAGE TREATMENT WORKS

DEEP AT DEEPHAMS



Busy site: An average of eight piles were completed every week

A decision to install a massive secant piled retaining wall to form the perimeter of a sewage treatment works' inlet pumping station shaft has cut temporary works costs by 20%. It has also slashed a valuable five weeks off the construction programme at the North London project.

And the challenging shaft design, resulting from the use of 29m long piles, has triggered further innovative construction solutions, saving yet more time and money.

"Our latest target is to capitalise on the 10-day Christmas shutdown through early completion of a crucial concrete ring beam support needed in the shaft," says Gavin Symonds, contracts manager for contractor J Murphy & Sons. "By allowing the concrete to fully strengthen while we enjoy the break, shaft excavation can restart on day one of our return to site."

Construction by Murphy of a new pump station and inlet works, at Deephams Sewage Treatment Works in Edmonton,

Innovative secant piling is cutting time and cost during construction of a deep pump station shaft at a North London sewage treatment works. **David Hayward** reports.

PILING AND FOUNDATIONS SPECIAL

will make the nearby River Lee cleaner and healthier for aquatic life while improving the riverside environment. The location and design of the new £35M-plus inlet works has been restricted by the location and route of the 20m deep sewer that it must connect up to.

The obvious construction choice for the 18.5m diameter shaft founded 24m deep in water-bearing Thanet Sands, was to use diaphragm walling – and Murphy tendered on that basis. Once on site, the team looked again at the constricted location and reconsidered the

construction method.

The only other option – secant piling – would require 29m long male piles driven through adjoining females either side and into the variable strength clays and gravels, to found in the cohesionless sands.

Assuming the female piles were formed of standard 20N/mm² concrete, boring the males to such considerable depth – and to the required 1 in 200 verticality tolerance – was initially considered tough going and risky.

"Installing such a deep secant-piled shaft wall is pushing the boundaries of what is acceptable in the UK," explains David Beadman, director for Murphy's geotechnical consultant Byrne Looby Partners. "Around 19m depth would be considered the absolute limit."

But also on board was

the contractor's own piling division with experience of working in Ireland where use of lower strength concrete for female secant piles is often successfully adopted. Armed with this confidence, the team opted to trail blaze a UK first and halve the concrete strength of the 24m long female piles to just 10N/mm², making it considerably easier to drill the longer males.

The relevant British Standard, BS8110, does allow such lower strengths for unreinforced concrete – as the female piles are – though, as Beadman points out; "UK practice tends to adopt a typical 20N strength for such piles."

As a bonus, Murphy hired a brand new £2M Bauer BG40 piling rig. With its impressive 40tm torque, use of the rig at Edmonton was correctly predicted to considerably ease the drilling operation. It has proved a worthwhile addition, with the original 17-week piling programme cut by five weeks.

To help ensure such long piles would keep within the required verticality, a hefty concrete



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» guide wall was laid to 5mm accuracy and the 76-pile shaft perimeter set out on two radii.

As the 1.2m diameter males are drilled through adjacent females, creating a total 320mm overlap, the slightly larger concrete mass of the female being cut into on the inside of the pile circle creates a possibility of pushing the descending male out of alignment.

This could result, as Beadman puts it “with the pile popping out of the circle so destroying the shaft’s required water-proofing”.

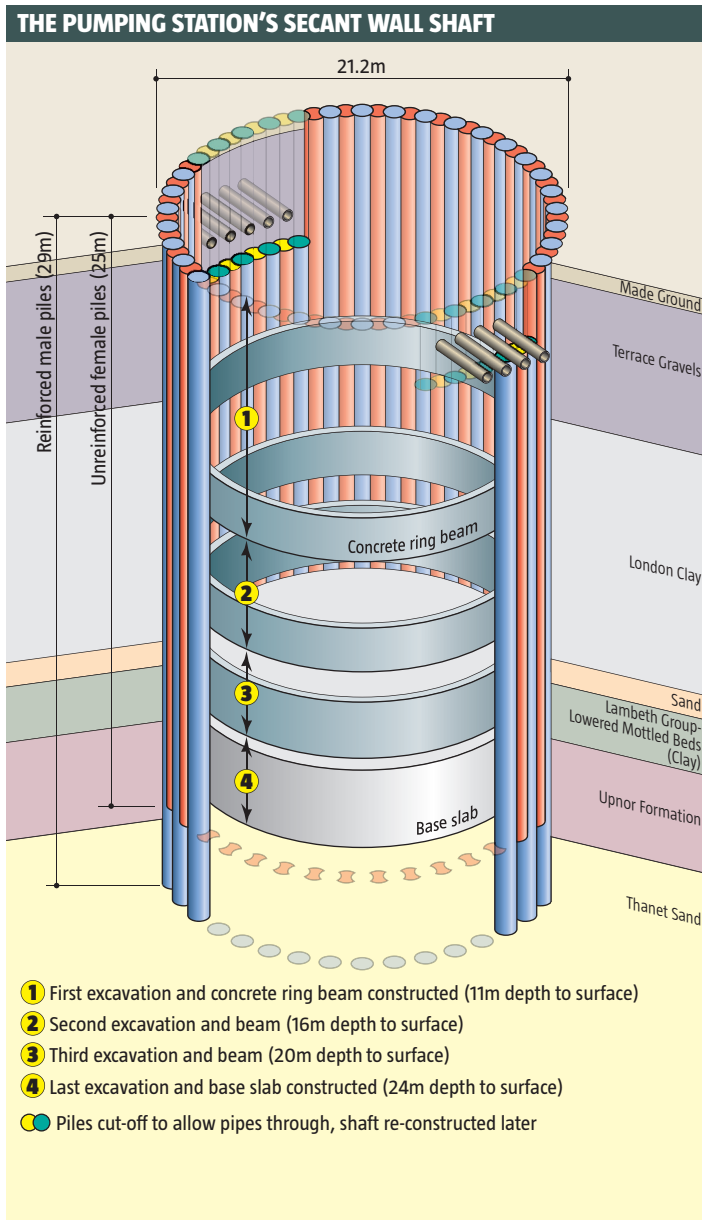
To remove this risk, engineers have adopted the novel approach of setting out the radius of each male pile exactly 65mm inside that of the females. This places each male pile on a straight line between adjacent females.

Another innovation is the C8/10 concrete mix design, which demands a balancing act between conflicting needs. The shaft’s secant pile perimeter is technically all temporary works, as a structural 600mm thick internal concrete lining will later take over ring compression forces.

But the piles’ deadweight is still needed to act as flotation resistance in the wet lower ground strata, and the females’ C8/10 concrete is a real minimum and maximum strength. Additionally, the piles have to resist the corrosive effects of the surrounding ground’s high sulphate content – a demand pointing to extensive use of sulphate-resisting cement.

The mix adopted blends these two requirements. Sulphate resisting cement is not used, but over 90% of the conventional cement is replaced by a secret mix of granulated blast furnace slag and admixtures.

With all the piling due to be complete in late November, Murphy’s Gavin Symonds



COMPLEX DESIGN

Use of secant piling to form the 24m deep shaft, calls for complex structural design.

A row of horizontal pipes, penetrating the piles just 6m down the shaft, means that upper sections of the wall act not in ring compression but as a cantilever with forces transferred down below the pipes.

At 11m deep, there is a need for a compression ring and it is here that the first section of half thickness permanent concrete lining will be cast just before Christmas to double as a temporary works beam. Two further similar beams are needed at 16m and 20m depths. Aecom is Murphy’s permanent works designer.



Record length: A 29m rebar cage

reflects on the success of the contractor choosing secant.

“Not only has piling, at around £1.2M, proved 20% cheaper, but it has also saved us an estimated six weeks on the diaphragm walling tender programme,” he says. “Plus, the piling itself has been completed five weeks faster than planned.”

Contributing to this claim was the decision to bring in a second set of pile casings to maximise rig use. While one pile was being concreted, the BG40 was starting to drill a second bore.

This simple addition to the site’s arsenal increased pile rates from four and a half to eight a week, and saved almost three weeks.

Symonds calculates the basic financial gains of such a move: “The £9,000 hire cost of the casings, set against taking the rig off hire three weeks early – saving us £84,000 – illustrates the obvious win-win solution,” he argues.

Similar innovation resulted when solving the conflict of a 4.2t pile rebar cage, 29m long, having to remain stable in its founding medium of water-logged sands. It could not be allowed to move while either being surrounded by pile concrete or during follow-on casing removal.

The simple solution was to weld a flat steel plate across the bottom of each reinforcement cage to act as a steady base – and it worked.

With piling complete, and shaft excavation starting, Symonds is keen to dig out the upper 11m of material before the site’s Christmas shutdown. At this level the secant walls will need their first internal support.

But, instead of installing conventional temporary steel walling supports, Murphy is opting to cast a narrow 2m wide section of permanent concrete lining around the shaft to act as a ring beam.

Concern over achieving, at this excavation stage, the required concrete finish on the lining – plus the need to easily incorporate the beam into the main lining as it is later cast upwards from the shaft bottom – will result in the beam being formed only half the lining’s full 600mm thickness.

And it is this beam that needs to fully cure over the Christmas break, offering Murphy a running start in the New Year.