GROUND ENGINEERING

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DUBLIN'S FLOATING BASEMENTS

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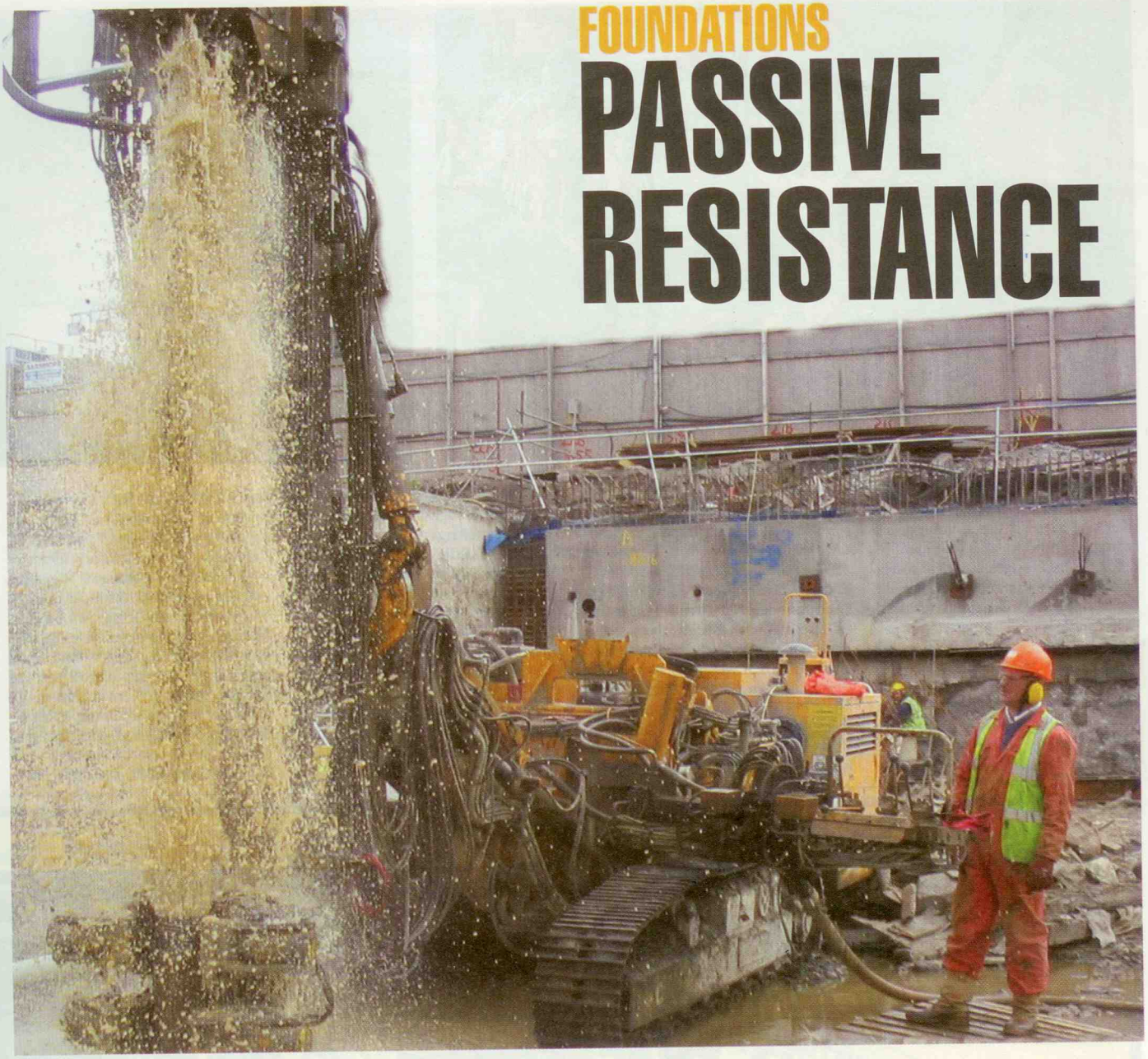
FOUNDATIONS

PASSIVE RESISTANCE



Dublin's basements have a history of misbehaviour. Damon Schünmann investigates what is being done to keep them in place.

Floating basements may sound like an amusing contradiction to the uninitiated, but to Dublin's contractors, it is a very serious business. A combination of high water table and high porosity ground means that sites close to the River Liffey require careful consideration if they are going to stay put.

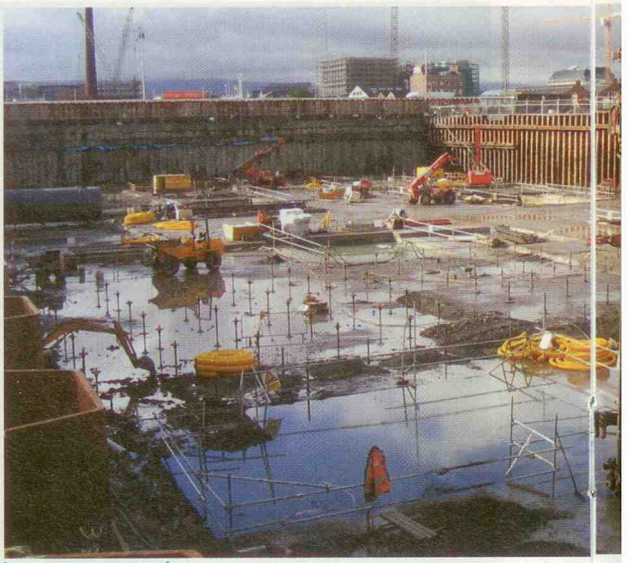
For a new PriceWaterhouseCoopers office on the north side of the river, groundwater is about 3m below the surface, about 6m above the underside of the basement slab. This generates a powerful uplift.

Cementation Foundations Skanska's answer is 63.5mm diameter fully threaded passive bar anchors fitted to a circular steel head plate. This plate is held in place by a full-strength nut and is cast within the basement slab to tie it to the ground below. These anchors are founded a minimum of 9m into the site's hard black boulder clay.

Cementation won the £700,000 contract from main contractor John Sisk and Son and is putting in 682 anti-flotation bars at the Spencer Docks site. The two level basement, which extends down around 8m, will form the car park.

At the south end of the site nearer the river, the clay band begins to drop away and a layer of silt sits above it. The bar anchors are extended in these areas using full strength couplers to maintain the required penetration into the underlying competent stratum.

Cementation manager (ground



engineering) Philip Ball says: "As the ground deteriorates towards the river we have to use a temporary casing to support the hole and it takes a lot longer." This softer ground means that the boreholes are three times more expensive than those in the more competent ground at the northern end.

To ensure the bottom ends are completely protected with grout coating, site workers suspend the anchors inside the boreholes with spanners while it goes off. This also allows the top of the bar to be accurately positioned 900mm above the blinding concrete.

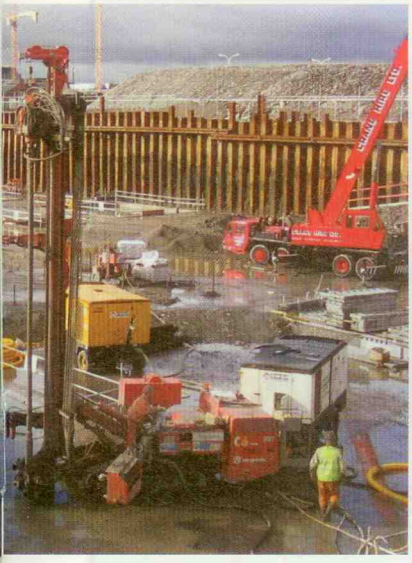
As a final precaution, the anchors are fitted with anti-corrosion 125mm diameter corrugated UPVC ducts. According to Cementation contract engineer Troy Richardson: "These are used because when the anchor is under load, the grout may crack and then water can seep in."

At first, temporary dewatering to a level of 0.5m below working platform level prevents the basement slab from moving. This dewatering however, still does not prevent water from issuing from the 220mm bores while the Casagrande C6 down the hole hammer rigs are drilling.

As the building is completed and the pumps are turned off, the bars go into tension. Interestingly, as the load from the building works increases but before the pumps are turned off, the anchors can also work effectively in compression.

The total number of anchors and their distribution within the basement slab needed to counter heave was determined by consultant O'Connor, Sutton, Cronin & Associates. It has also calculated the optimum numbers of anchors, capacity, spacing, head plate detail, slab thickness and reinforcement.

But for the technique to work, says Cementation technical manager (ground engineering) Jim Martin: "You need a competent stratum at a relatively shallow depth below the basement". The geology at the site fits the bill, being 2m to 3m made ground overlying alluvium and several metres of dense water-bearing gravel. But it is the boulder clay beneath this that makes the scheme



Second strand

Cementation Foundations Skanska clocked up another first for the city on a £4M-plus contract for client Fusano Properties.

As subcontractor on the residential development in the Smithfield area of the city, a diaphragm wall was preferred over a secant wall because of the difficult ground conditions. Technical manager (ground engineering) Jim Martin says it was thought piles would have been thrown off by the cobbles and boulders in the ballast.

Over 500 temporary strand anchors were installed to hold back the diaphragm walls until the basement floor slab have been cast. These 15.2mm Dyform strand anchors (four strands per anchor) are able to withstand up to 75t and are de-stressed once the basement floor slabs are built.

Even though main contractor G&T Crampton used dewatering to keep Dublin's high water table down, the rig crews still had to contend with fountains over 5m high. The 21 wells at the site are now being turned off and Martin says: "Each well is producing up to 60 litres/m of water. The strain gauges for the ongoing ground monitoring are clearly showing the bars going from compression into tension."

But these jobs in the challenging Dublin ground are all part of a fine-tuning process to help optimise future schemes. Martin says: "It's all very well using theoretical models but we need to understand how they are performing in the field in the long term."

Between October 2002 and July 2003, 288, 1,100kN safe working load passive anti-flotation bars to 12m were put in, founded 6m into the Calp limestone.

The significantly lower number of bars used for this job compared to the Spencer Docks site is because the limestone allowed for greater capacity. Also, the central atrium within the PriceWaterhouseCoopers building reduces dead load on the ground and so more anchors are needed below this area.

possible – and this in turn lies on very strong Calp limestone.

Ball says: "Despite the fact it's called boulder clay, it drills like a soft rock. You couldn't do this kind of job in most areas of London because the clay has all the wrong characteristics." Martin adds: "The rising water in London means you have a moveable feast."

In the past the problem of the high water table has been tackled using stressed anchors, but the passive anchors have distinct advantages. "Stressed anchors would have required expensive head pockets as well as the need to drill through the slab to put them in. There are a lot less risks in the long term because there are no risks of leakage," says Martin. The fact that passive anchors have not been widely used before, he puts down simply to conservatism.

But when a basement must resist $10kN/m^2$ pressure per metre depth into the water table, passive bar anchoring, like other anti-flotation techniques, can still be unsuccessful. Failure divides into two main types. The first is bond failure, where an individual column of grout comes out of the ground and the second is block failure, where a whole group of piles, perhaps a whole slab, comes out of the ground.

Ball explains: "Block failure is hard to predict because you cannot be certain of how the ground is going to behave. But you can test for bond failure with pull out tests and we've done them to 1,200kN."

Although the anchors at the site will be holding down the basement, the weight of the structure is also resisting the uplift pressure from the water table. Calculations on how many anchors are needed must take this dead load into account.

Even if the passive anchors at the site at first appear to be overdesigned, with each 63.5mm anchor able to take a 110t load, the design called for a maximum movement of 5mm at 60t because of structural tolerances within the new building.

Cementation will complete bar anchor installation in December this year with the building scheduled to finish in autumn 2006.