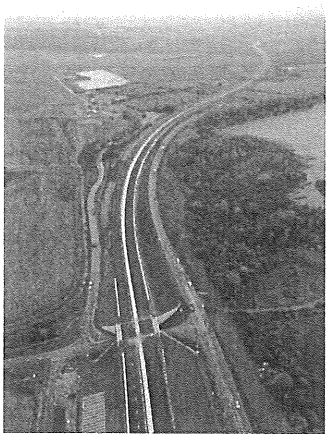
STEADY WORK, INNOVATIVE IDEAS

Innovative ground engineering solutions were celebrated at the 2010 Fleming awards last month. By **Adrian Greeman**



Using compressed, used tyres on the A421 improvement in bales turned was similar to laying bricks

Ground breaking use of tyre bundles for lightweight road embankments took this year's Fleming Award despite some strong competition. The winner was up against detailed entries from a difficult analysis of cofferdam stability in a tidal zone and from a major London air-rights station scheme which used complex micropiling and pile reuse.

After hearing presentations from the three shortlisted projects, the British Geotechnical Association judges panel decided that the unusual and economical tyre bales solution to an awkward problem had mobilised excellent cooperation between client contractor and designer.

"The untried method carried risks, and it was a brave decision to go ahead, backed up with necessary testing and documentation which helped convince the client, by going through all the necessary technical steps. Buy-in was secured from the Highways Agency and the county council which will manage the road," said judges chairman Dinesh Patel, director at Arup Geotechnics.

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Dinesh Patel, Arup Geotechnics

The judges said the team had thought about the immediate project and the strong potential for future use of tyre bales "which indicated their desire to improve the industry generally". The £3,000 prize was awarded to the winning team of Alex Kidd from the client Highways Agency, Stephen Beales from designer URS Scott Wilson and Russ McNeill from contractor Balfour Beatty Civil Engineering.

The project was a section of improvements to the A421 road in Marston Vale between Junction 13 of the M1 motorway and Bedford, a route which is part of a key east to west corridor linking the university towns of Oxford and Cambridge (*GE* October 2009). Around £200M is being spent to dual a 13km stretch of the road, greatly increasing capacity and relieving congestion.

A short length of the road passes the edge of the small Brogborough lake said Kidd, At this point the main carriageway and a realigned section of side road had to cross a former clay borrow pit, on embankments up to 7m high. The excavated pit contained a number of clay slurry fans, the result of spoil deposition from a second adjacent pit. »

» These were made of soft material up to 21.5m deep.

For the main carriageway, a piled support with a geotextile load transfer platform was selected to cope with this. The slip road was done with a surcharged lightweight embankment, with a six month maximum for loading. In places wick drains were also used. In low embankment areas, lightweight fill was chosen for soil replacement.

For this purpose PFA would have been too dense and would have had to be placed in stages. Commercially available fills such as Maxit expanded clay were considered too costly. So the contractor proposed tyre bales during Early Contractor Involvement discussions. These were cheaper and recycled material that would otherwise be incinerated.

The bales are made by compressing used tyres into bundles 1.5m long and 0.8m high, secured with wire straps. The bales have a fairly low density of 500kg/m^3. But they needed to be carefully assessed for engineering properties as well as for durability, and fire risk. The team was able to draw on information from suppliers and also from Mike Winter of TRL who has been championing their use. An existing PAS 108 specification for consistent production of the bales was used.

In construction, the bales were used in layers to build up the embankment above a Maxit working platform used for drain installation. More Maxit was used to infill gaps and the whole was enclosed with a geotextile, above which a 1m layer of conventional fill created space for services.

Balfour Beatty looked around the UK to find existing uses of tyre bales. They had been used in walls and some other structures though never before in embankment.

"There was a feeling it would be complex element of the job" said McNeill, "especially on a soft ground area." In the event he said, it turned out to be one of the easiest and fastest sections. "It is almost like laying bricks."

Some 3,000 bales were laid up to six deep in just under a month, he said. A small excavator-mounted handling clamp was developed for the operation. The bales were easy to move, handle and store and could be obtained from three or four suppliers in the country.

"Time saving was of great programme benefit which saved up half a million pounds in itself," says McNeill

The lessons learned have since allowed the use of the bales in other projects elsewhere in Balfour Beatty he says.

SHORTLISTED: ST GERMANS PUMPING STATION

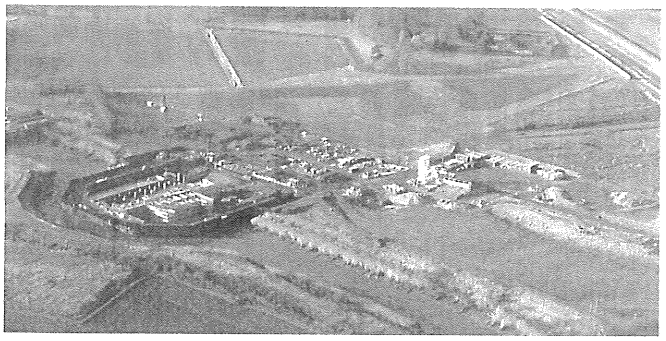
Among the contenders for this year's award was the stability analysis of a large coffer dam for a major pumping station project in the Fenlands of Norfolk. This work may well have saved 70,000ha of this low lying flatland from being inundated by the sea.

The St German pumping station project for replacing a 1930s facility involved one of the largest coffer dams in Britain, a three-sided 85m wide square box formed from double sided sheetpile cells 10.5m across. The sheet piles were tied together and the cell interiors infilled.

This dam on the so-called mid-level drain, a large canal watercourse through the Fens, enclosed the worksite for the new pumphouse which lifts water into the tidal estuary of the river Ouse.

"But it also cut through the sea protection embankment during the construction period," said professor David Richards of Southampton University, one of the project team. "So any failure would have had a severe effect on 25,000 inhabitants and an economic impact of over £3bn." He was joined by Chris Pound of consultant Mott MacDonald and Bill Hewlett from contractor Costain.

The coffer dam was founded in a layer of Kimmeridge clay underneath soft Fen deposits.



It had been designed initially with a standard assumption for such temporary works which was that low permeability of the ground layer would allow it to be treated as undrained. This would suffice even though the outside of the cofferdam was subject to a potential 7m tidal range plus a 2m tidal surge, because it was taken that the pore water dissipation would be too slow to affect stability.

But it turned out that permeability was not as low as expected, particularly horizontally in the laminated layer structure of the "shelly" Kimmeridge. Measuring the tide cycles, extreme event surges and spring tides suggested that pore pressure dissipation might be quite fast in some circumstances, with up to 30% loss in one hour and 90% in a day.

An analysis using a drained condition for the ground was suggested, therefore. Studies with FLAC numerical software showed a shock result; although an analysis using an undrained assumption showed the cofferdam would remain stable even with a 7m tide, the drained analysis showed that it would fail at that level.

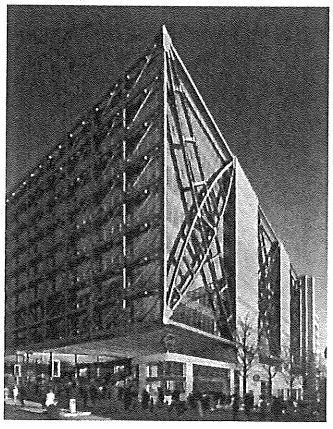
As a result, significant design changes were required. The cofferdam was widened in parts and a granular toe berm was added. Rows of piles for the permanent structure were strengthened to allow them to work as support for the cofferdam too and the fill was dewatered in the cofferdam cells. The dam did successfully withstand a major surge event in the North Sea in Easter 2008 which brought tides of over 7m.

SHORTLISTED: CANNON STREET STATION FOUNDATIONS

The difficult air-rights construction of an £360M eight-storey office block and retail podium above the tracks and concourses of the City of London's Cannon Street station was the other shortlisted project. The railway station and the Underground station which passes under the entrance were also remodelled.

Complexities of the scheme's foundations included: the presence in the ground of a vitally important and protected archaeological discovery; the presence above ground of 1868 Victorian brick arches supporting the tracks; and existing giant under-reamed piles from a 1960s office block. This building over the station was demolished to make room for the new development.

"Pile locations were limited both to the line of the platforms



at the track end and of the arches, which also constrained headroom," explained Tony Taylor from designer Foggo Associates. He was joined at the awards by Hugh St John of CGC and Jim Martin of Byland Engineering.

The design solution was to form the entire building as a steel exoskeleton box supported on two platforms at one third points and cantilevering at either end, across the platforms and across the front concourse area. For the northern foundation, the large under-reamed piles were re-used, with new "settlement reducing piles" bored adjacently to attract additional load where this exceeded the original. Reusable load was estimated from the demolished dead loads.

For the southern end, an innovative method of micropiling in a "box" formation was used, the piles forming a perimeter to an enclosed column of London Clay that mobilised its strength as a large "ground pile". The method allowed less intrusive construction than equi-spaced pile groupings.