BASILDON FUNDS FOUNDATION CHECK

BASILDON may not be the most fascinating place in Britain but there is an interesting piece of civil engineering research underway on the foundations of the Essex new town's latest shopping complex.

Building Research Establishment, Surrey University, Basildon Development Corporation and consultant White Young are monitoring instruments under Allders department store to find out exactly what happens when a large amount of clay is removed and replaced by a building which weighs less than the original ground.

White Young must have had a fair idea what would happen in order for it to design the new store in the first place.

But Basildon has had a number of structural problems due largely to insensitive foundation design and construction in the all too sensitive clay on which the town stands. So the local development corporation agreed to spend £14 000 on detailed foundation analysis during the current round of construction to increase knowledge of ground behaviour in the district.

Allders department store is a 100m long, 50m wide three storey block which forms a substantial part of a £50M shops and offices complex. The store is now being fitted out by John Laing following structural completion earlier this year.

Gross foundation pressure at the base of the building is expected to be 70kN/m², but the original ground pressure at basement level was 90kN/mm², leaving a net negative pressure — or heave — of 20kN/mm².

While designing to structure, however, White Young was advised by Professor Noel Simons of Surrey University that the actual uplift on the basement could be less than the theoretical for two reasons.

First, some heave would take place between excavation and the slab being cast. Second, if a piled foundation was chosen the piles would tend to act as reinforcement in the ground and carry some of the heave pressure.

This last reason was a factor in White Young's decision to plump for a piled raft foundation rather than a pure raft, although other items came into the equation. The Allders building, though structurally separate from the rest of phase two development, will support one side of a glass roof covering an adjoining shopping mall and actually butt up against a nine storey office block. Any risk of differential movement induced by a 'floating' raft was to be avoided. Also the large column spacings specified by the client would have resulted in a raft of considerable thickness.

Having decided that the building would not rise out of the ground as soon as it was built, the problem then was to work out how the loads would distribute themselves between the piles and the slab in order to produce an economic design.

Normal practice for piled basements in clay is to assume that all building loads are carried by the piles and then design the basement slab to resist a heave pressure equal to the relief caused by excavation. But — as mentioned by Simons — a substantial proportion of heave can be carried by piles, so great savings are possible in the cost of a slab.

Conversely, savings can be made in pile compressive strengths if it is assumed that a proportion of building load is carried by the slab.

A detailed computer analysis was undertaken with the help of main contractor Laing's in house design department, and a figure of 67% was finally decided upon for the proportion of building load which would be carried by the piles. This compared favourably with the results of four case studies of foundations published in 1979, including the Natwest tower, which showed piles to be carrying between 55% and 75% of the building load.

But in all the case studies the net foundation pressure was substantial, unlike, the theoretical negative value at Basildon. Nevertheless Simons pointed out that significant swelling of the clay will not have occurred by the time the store is finished, so pressure on the slab will be at a minimum.

Pile tension loads were set at 85% of the theoretical maximum relief pressure less the minimum deadweight of the building, while slab uplift pressure was taken as 70% of the relief figure alone.

Having decided on all these values, there was considerable interest in monitoring what actually did happen once the building was complete. BRE installed 15 load cells under the concrete as the slab was being cast and attached a further 52 to the reinforcement of four piles (*see diagrams*). Another four slab cells were installed under the adjacent shopping mall basement.

Monitoring started in September that year, and a plot of the loading on three of the piles during the first few months is shown here. The results from the fourth pile are rather unclear due, it is thought, to water table fluctuations.

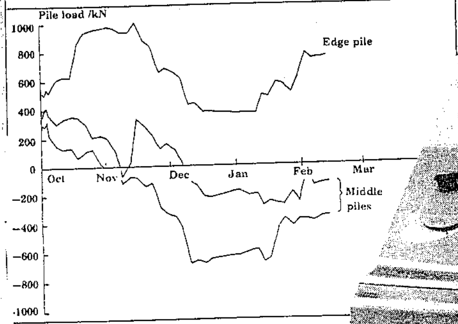
The initial plot clearly shows the middle piles quickly going into tension, though this is well within their tensile design capacity of 4100kN. Now that the building has been recently finished, all four piles are back in compression. 'But it remains to be seen whether they will stay that way' says White Young associate in charge of the project Charlie Rickard.

Rickard says that though the readings from the cells are taken twice a week, little has been done so far to analyse them. 'Next month Surrey University is to start a detailed analysis funded by a Science & Engineering Research Council grant' he says.

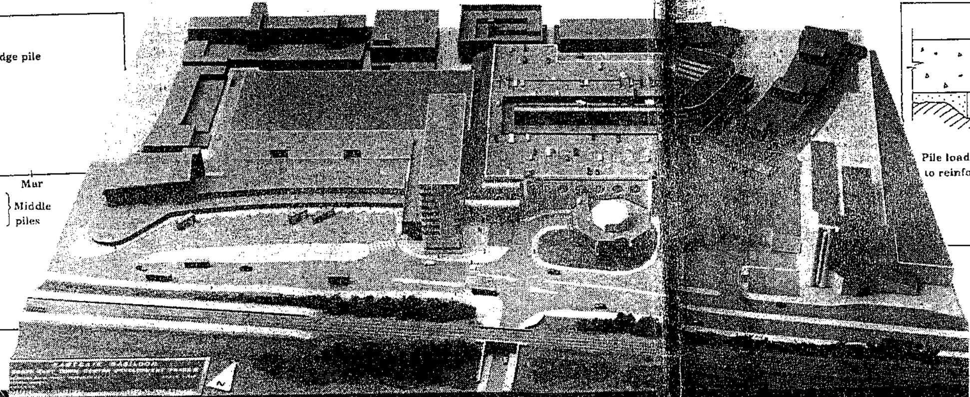
'Not only will this show how the loads are being distributed between the slab and the piles, but the various readings from the 12 or 13 cells within each pile will also indicate pile bending moments. These are already significant.'

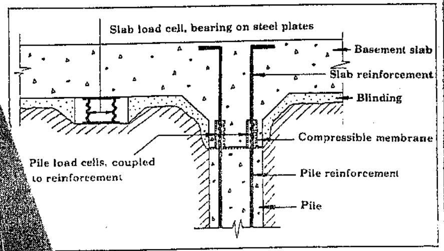
Rickard praises the cooperation his firm has had from BRE, Surrey University and Basildon Development Corporation in enabling the investigation to take place. 'But Basildon also had a more practical reason for installing the cells' he says. 'If something happened to delay the contract before the building was substantially complete, it would be important to know what was happening in the time it took to get rolling again.'□

SIMON FULLALOVE



ABOVE: Plot of pile loads during the first five months of construction. All piles are now in compression.





ABOVE: Schematic illustration of how the pile loads and slab loads are measured. Each of the four piles being monitored has 12 or 13 load cells spread across the section capable of carrying all compression and tension forces for which the pile was designed. Cells were designed by Gerwin Price of BRE.

LEFT: Model of the £50M Basildon town centre development. The Allders department store, is the large low rectangular block to the left.

LEFT: White Young associate in charge of the £50M Basildon project, Charlie Rickard.

BELOW: Layout of the piles and sections of basement slab being monitored in Allders department store. The building is basically rectangular in plan so only one quadrant is being looked at.