Zeitschrift: IABSE structures = Constructions AIPC = IVBH Bauwerke
Band: 11 (1987)
Heft: C-43: Excavations

Artikel: Deep basement at the British Library, London (UK)
Autor: Smyth, W.
DOI: https://doi.org/10.5169/seals-20393

7. Deep Basement at the British Library, London (UK)

Client:	*Property Services Agency on behalf of the British Library*
Architect:	*Colin St. John Wilson & Partners*
Engineer:	*Ove Arup & Partners*
Construction Managers:	*Laing Management Contracting Limited*

Introduction

The British Library, now being built in London, will be able to store 25 million books and has a design life of 500 years. There are railway tunnels crossing the site and also close beside it which have affected the planning of the building. A large part of it is under ground and this note deals mainly with the construction of the deepest basement, shown on the right of Figure 1, which will be used for storing books handled by automatic machinery.

The basement is roughly 100 m × 100 m in plan and required excavation to a depth of 26 metres. Construction methods had to be devised to keep ground movements to a minimum, to avoid damage to the tunnels and to nearby buildings. A top down construction sequence was used so that each floor slab was constructed as soon as the excavation had passed it (Figure 2). The slab could then act as a prop to the perimeter walls, before the next stage of excavation took place underneath it. Inside the basement are steel columns which carry the slabs during construction and act compositely with a concrete casing to carry the superimposed dead and live loads. Each of these columns is founded on a single large diameter bored pile with an under-ream between 3 and 4.2 metres in diam.

Pile test

The construction procedure for the deepest basement causes the piles to be progressively loaded as the floor slabs are constructed, while the surrounding soil is being unloaded at a greater rate by the excavation.

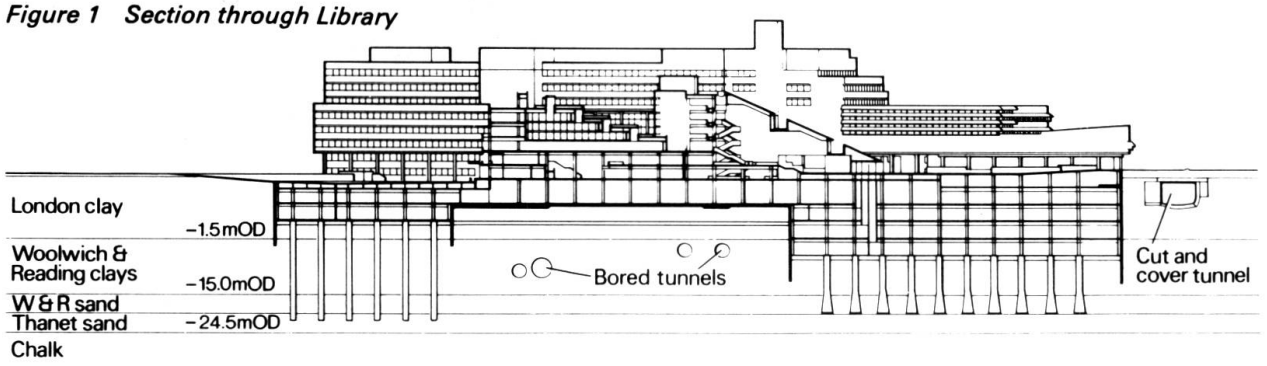
A pre-contract pile was necessary in order to obtain sufficient data for the final design. A 1.5 m diameter test pile was loaded up to 2700 tonnes. It had a soft polystyrene base and was partially sleeved for a length equivalent to the depth of the basement in order to measure the skin friction. The pile was instrumented with six rod extensometers, three magnetic ring extensometers and sets of vibrating wire strain gauges.

Predictions of movement

A detailed study was made to predict the effects of construction on nearby buildings and on the railway tunnels, which in some places are close to the underside of the central raft. A new analytical model for the behaviour of stiff clays was developed and used in conjunction with finite element analysis. The model was calibrated in various ways and its validity tested by back analysis of existing deep excavations, before being used for the British Library.

It was demonstrated that the long term effects on the bored tunnels could be determined by the pore water pressure finally established and methods of controlling this were recommended. The magnitude of distortion in the tunnels due to relief of overburden was predicated and the tunnels have been instrumented to measure the actual movements. Buildings within 100 m of the site are being monitored.

Figure 1 Section through Library



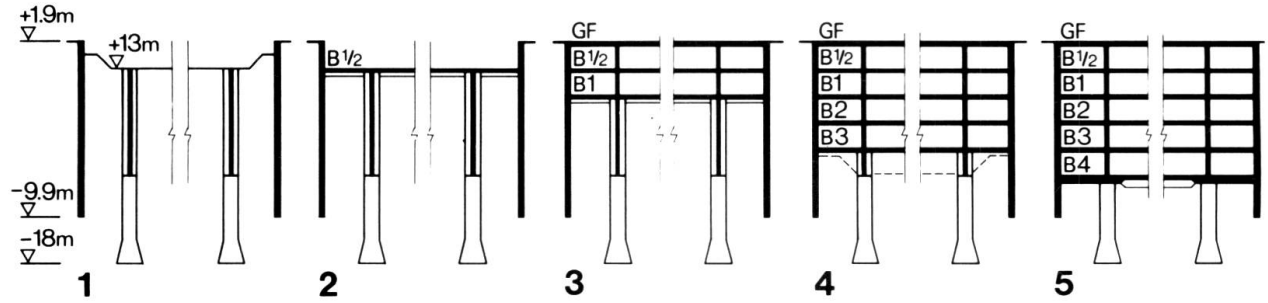


Figure 2 Top down construction of deepest basement

Figure 3 Central area excavation

The deep basement is on the right, showing the column heads of floor B1. A perimeter wall with ground anchors can be seen in the left bachground.

Construction of deepest basement

The construction sequence was crucial for the ground movements, and for predicting them, and was specified and controlled in detail. The site was excavated to remove old foundations and the perimeter walls were constructed from secant piles. The piles for the columns were bored and constructed up to the level of the lowest slab. Above this the holes were lined with corrugated steel tubes inside which the steel columns were erected (Figure 2).

Each floor was constructed as follows. The excavations was taken 650 mm below the underside level of the future floor slab, blinded with 50 mm of concrete, and shuttering was erected on which the reinforced concrete slab was constructed. After construction the shuttering had to be removed within a limited time to prevent the slab being damaged by heave of the clay. Excavation below the slab was started by an excavator with a backhoe and then carried out by bulldozers providing spoil to an excavator with a grab. The procedure was repeated for the next floor down. For the deeper excavations various expedients were used to get the soil to the surface, involving multiple handling. The most critical floor was the lowest, because it is nearest to the toe of the perimeter wall and the ground removed next to the wall had to be replaced as quickly as possible by the slab. The slab is in contact with the ground around the perimeter and there is a space of at least a metre under the rest of it.

Figure 4 Floor B1 under construction

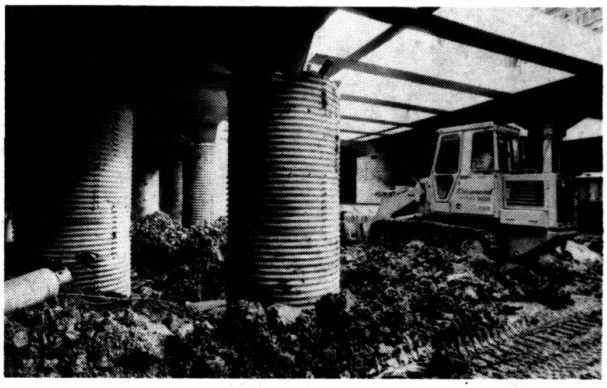


Figure 5 Floor B1 being excavated

Other basements

The other basements are shallower and have been constructed in open cut. Ground anchors were used to control the movements of the perimeter walls.

Water table

In London, as in many cities in the developed world, the water table has been depressed by extraction of water for industrial use. There is now much less extraction and the water table is rising again. A rise back to its natural level has been allowed for in the design of the foundations of the Library and 31 pressure relief wells have been installed under the deep basement, so that the water table can be depressed locally if it should become necessary in the future. Another 19 were installed to control pore water pressures in the area of the bored tunnels.

Programme and costs

The library is being constructed in a number of stages, depending on the availability of funds. The works so far constructed are:

1982–83 oversite excavation to remove old foundations, construction of diaphragm walls and deep piles,
1983–84 fabrication and erection of steel columns,
1985–87 top down construction of deepest basement.

The superstructure of the central area and over the deep basement is under construction and will be open to readers in 1993.

(W. Smyth)

Reference

Simpson et al, A computer model for the analysis of ground movements in London Clay (1979). Geotechnique 29, No. 2, 149-175.