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Deep basement construction

in Central London

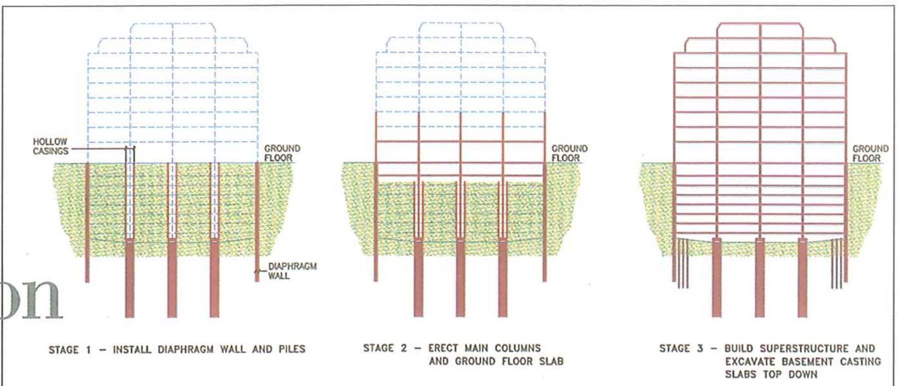

Fig 1: Top down construction sequence

Constructing one of the deepest basements in London requires exceptional care to ensure stability of adjoining buildings, roads and services. Heave of the soil as it is unloaded is minimised by the simultaneous construction of the building above.

The 25m deep basement to 156 Aldersgate Street, London EC1 was excavated within a 1.0m thick, 30m deep, perimeter diaphragm wall, with the simultaneous construction of an eight-storey office block above ground level. The project was rare in size and depth of excavation, involving the removal of 126,000 tonnes of London Clay (*Sunday Times* 'Innovation' 21 February 1988). Extensive monitoring was installed to confirm design assumptions.

Excavation was by the 'top down' method whereby floors are cast as excavation proceeds, with the simultaneous construction of the building above (Fig 1). The floors immediately act as props to the perimeter wall to allow safe excavation to proceed below.

The key indicator to the integrity of such an excavation is the movement of the wall; during construction, movement at higher level is important. In the long term, the toe of the wall, some 10m below the lowest slab, continues to move as the surrounding clay returns to equilibrium.

Extensive analysis, assisted by Professor John Burland, of construction and long-term performance, including the predicted 60m rise of the water table in London, showed that the excavation was safe, albeit that at the lowest excavation level the soil required reinforcement with vertical tension piles to ensure adequate factors of safety.

The primary monitoring systems installed in the walls were four arrays of electro levels cast into the walls. These sensors detect rotation of the wall from which curvatures and deflections can be derived.

It was immediately evident that assuming the top of the wall to be fixed once the slab was cast was an over-simplification and more consistent trends were found assuming the top moved cyclically annually by ±3mm. Corrections for long-term creep and shrinkage of the slab were also introduced into the data analysis.

The first ten years of monitoring have shown a high degree of consistency of behaviour of the four sets of observations, although absolute values of deflection do vary from train to train as is the nature of the behaviour of soil.

Fig 2 shows a typical example of the results over a ten-year period. Deflections and curvatures are within the predicted range and propping forces at slab levels derived from deflections at slab levels are also consistent with predictions.

Ten years is, of course, a relatively short period in predicting the final equilibrium conditions of such a large basement. However, plots of toe deflection against log (time) when extrapolated for the next 100 years show that further deflections in the order of 5.0mm can be anticipated.

This monitoring exercise is rare with respect to the depth of the excavation and the length of time of observations. It is further evidence that the predictive tools we have available sensibly model the behaviour of deep basement construction both during construction and in the long term.

For many years, the presence of London Clay, rather than rock, under Central London has been regarded as a practical limitation to the economics of tall buildings. Whilst tall buildings in London are not currently favoured in townscape terms, the ability to construct very deep basements safely, with simultaneous construction of the superstructure, provides an economic foundation engineering solution for very tall buildings in London. At 156 Aldersgate Street, construction was limited by planning constraints to eight storeys. In fact, the soil bearing pressure available at the lowest basement level would theoretically have allowed the construction of a 30-storey superstructure. ■

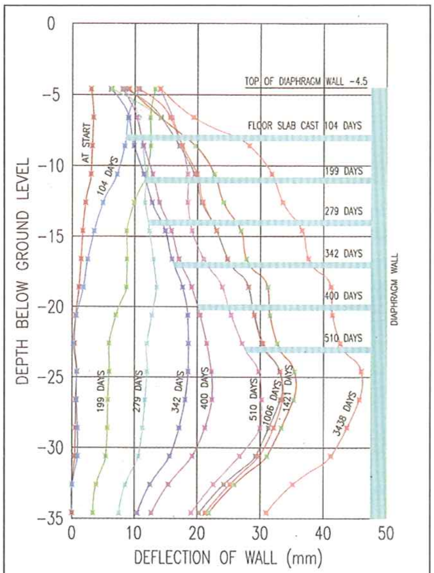

Fig 2: Typical deflected profile of wall varying with time (days)