

## PLAXIS Analysis of a Basement Excavation

Excavation of a new basement level was required as part of a major refurbishment and extension of an existing apartment block in central London. To demonstrate that the proposed method of excavation would have a negligible effect on the existing properties, RJM Ground Solutions carried out a detailed analysis of the various stages of basement construction using PLAXIS 2D software.

### Company

RJM Ground Solutions (RJM) is a small geotechnical consultancy specialising in high quality geotechnical advice and designs to a diverse range of clients across the UK including BAM Ritchies, Murphy, JBA Consulting and RG Parkins & Partners Limited. RJM prides itself on the personal service and attention to detail that only a small company can provide. In addition to numerical simulation of soil structure interaction, particular areas of expertise include design of slope stabilisation solutions and mine treatment schemes.

### Challenge

Excavation of a new basement level was required as part of a major refurbishment and extension of an existing apartment block in central London. The proposed excavation was within a very congested former car park area and would take place immediately adjacent to a row of 5-storey Georgian town houses, many of which were founded on shallow strip footings (see Fig. 1). In order to demonstrate that the proposed method of basement excavation would have a negligible effect on the existing properties, it was necessary to undertake detailed FEA (finite element analysis) of the various stages of basement construction.

RJM were contracted by the developer to undertake a detailed FE analysis of the contractor's proposed method of basement excavation and provide a report which could be submitted to 3<sup>rd</sup>-party property owners and their insurers. This work comprised a site inspection, desk study review of relevant data, numerical analysis and reporting.



*Fig. 1: The basement was to be excavated in very close proximity to sensitive Georgian properties in a congested central London site. (Courtesy: RJM Ground Solutions Ltd)*

### Solution

Prior to commencing numerical modelling, RJM undertook a site inspection to view trial pits and discuss the construction process with the basement contractor to ensure this was fully understood. In addition, a detailed assessment of site specific desk study and ground investigation information was undertaken. This was combined with a review of relevant technical papers on basement excavation analysis in central London. Based upon this work, a ground model and suitable soil parameters for the anticipated strain levels were selected for use in the numerical analysis.

The analysis was undertaken using PLAXIS, modelling soil behaviour using the Mohr-Coulomb failure criterion with granular fill and Terrace Gravels considered as drained and the underlying London Clay as undrained (as only the short-term displacements during construction were to be determined). Analysis was undertaken as a series of drained construction stages and as such no consolidation analysis was required to calculate intermediate pore water pressures.

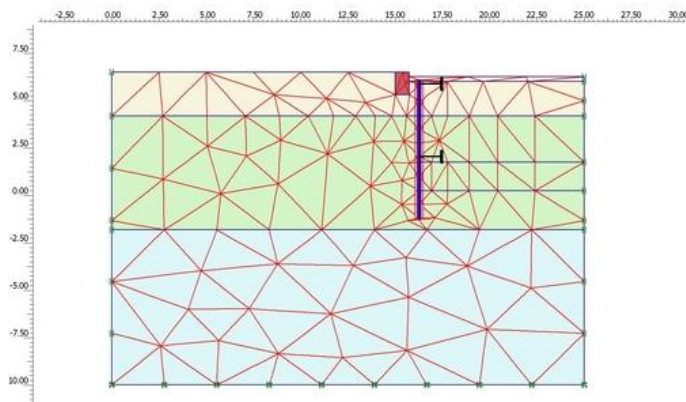


Fig. 2: Finite element mesh. (Courtesy: RJM Ground Solutions Ltd)

The strip foundations of existing properties were modelled as fully flexible to prevent soil from "hanging up" and giving a false reduction in true settlement. Piles were modelled as plate elements and floor slabs as fixed end anchors. Loadings from 3<sup>rd</sup>- party properties were applied as a combination of floor UDL and wall line load. The problem geometry was meshed using 15 noded triangular elements with local mesh refinement to the piled wall as shown in Fig. 2. The following stages were modelled to simulate the 6m deep basement excavation:

1. underpinning of the existing 3rd party boundary wall to a minimum depth corresponding to the underside of the pile wall capping beam
2. excavation to 0.25m depth and installation of permanent and temporary piles
3. excavation to 1.0m depth
4. construction of the ground floor slab providing an effective prop to the piled wall
5. excavation to 4.5m depth
6. construction of the basement floor slab providing an effective prop to the piled wall
7. local excavation to 6m depth
8. construction of lower level basement floor.

The results of the analyses carried out indicated that in all cases ground settlements adjacent to the basement excavation were less than 5mm. This confirmation that anticipated settlements were to be very small provided reassurance to the adjacent homeowners and allowed a suitable structural monitoring scheme to be designed with appropriate action levels.

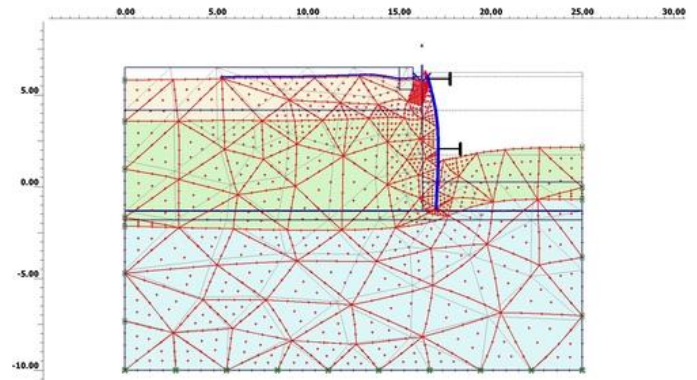


Fig. 3: Finite element mesh. (Courtesy: RJM Ground Solutions Ltd)

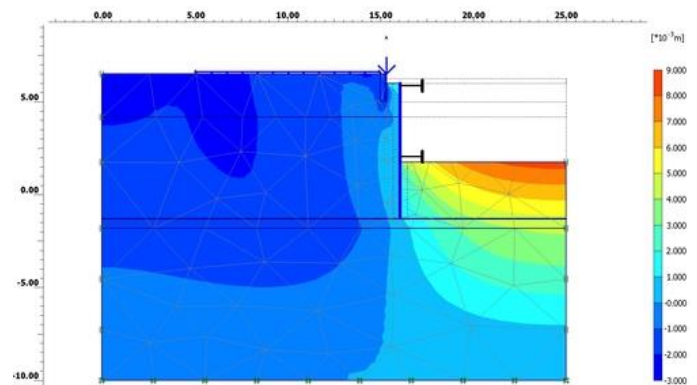


Fig. 4: Total vertical settlements following excavation to basement level. (Courtesy: RJM Ground Solutions Ltd)

## Business Benefits

“PLAXIS is an essential string to RJM’s bow and provides us with a competitive advantage over many of our competitors, both in the range and speed of analyses we can undertake. It allows us to present the results of complex analysis to clients in a clear and visually attractive way which really helps to explain our findings.”