# IT CAME FROM OUT OF SPACE

Computer analysis gave the confidence to use a novel support system in Ireland. **Gemma Goldfingle** reports

*Oasys software was used to design buttressed piles to support a three storey basement in Ireland*

Van Elle group chief design engineer Abid Adekunte is pleased that after nearly three years, his novel design for restraining a basement wall is being adopted again for a one-storey basement residential development.

The design involves installing raking piles around a contiguous piled wall and connecting them with a capping beam to create, effectively, a buttressed piled wall. Adekunte first trialled the system in a one and three-storey basement for a retail development in County Cavan, Ireland

Consultant Parsons Brinckerhoff with Van Elle were compelled to use this system in 2007 since the site in Cavan was hemmed in by adjacent buildings and a road. This left little room for a support system which extended much beyond the footprint of the building.

Around the site a contiguous wall of 600mm diameter piles, ranging from 9m to 17m in depth, was constructed in the Irish glacial till. At the shallowest points, where the basement was only one storey deep, the piles were left to cantilever. But in the deeper sections additional wall supports were needed.

"Conventionally, contractors and designers support retaining walls by using temporary props or tie-back ground anchors," says Adekunte. "Space shortage meant it wasn't possible to use props here. Tie-backs needed to be installed at a 45˚ angle, going beyond the site boundary, encroaching on adjacent land. The neighbouring owners were against this so we had to come up with an alternative solution."

"It wasn't possible to use props here. Tie-backs needed to be installed at a 45˚ angle, going beyond the site boundary on to neighbouring land" **Abid Adekunte, Van Elle**

Main contractor P Elliot wanted to maximise the space in the excavation area, so Quinn Piling with geotechnical consultant Parsons Brinckerhoff decided to use buttressed piles.

"By using buttress piles at an angle of 10˚, we could support the wall. While the buttress piles provide additional gravitational support to the wall, skin friction between the buttress piles and the surrounding ground will prevent the retaining contiguous wall moving during excavation. With only a 10º angle, the piles would also avoid encroaching on the adjacent land," says Adekunte.

As this solution had not been used much before, rigorous analysis was carried out using Oasys software. First the Oasys Stawal program was used to analyse the overall stability of the contiguous pile wall and calculate the required pile length.

Data was fed into the program detailing the soil properties including its density and shear strength. Static groundwater levels and the location of different strata was inputted into the program.

Information was then added about the proposed excavation levels and existing ground level, plus any surcharges on the ground. Using limit equilibrium analysis, Stawal calculated that the pile length had to be approximately 12m with a retained height of 7.5m.

Another Oasys software package, Frew, was used to predict the wall's performance. Designers entered details about the sequence of construction from initial stages to the installation of the contiguous pile wall, and construction of the raking piles to excavation and construction of floor slabs and permanent walls. The software package then calculated the active thrusts on the wall to predict the bending moments, deflection of the wall and service loads on the buttress piles. Frew calculated a maximum lateral deflection of 17mm in the cantilever single-basement section and 13mm in the buttressed piled sections, with the maximum service load of 505kN/m on the buttress piles.

"The software was essential. Different construction scenarios were easily assessed while sensitivity analyses were carried out using combinations of design parameters to allow for uncertainty in ground conditions and service loads," says Adekunte. Following this analysis, 600 continuous flight auger piles were raked behind the contiguous pile wall at an angle of 10˚ at regular 2m intervals.

As buttressed piles were a relatively new technique, extensive monitoring with inclinometers was carried out for five months during and after excavation to compare the actual wall movement with the predicted figures. Maximum deflection of the cantilever section was measured as 12mm and the buttressed wall achieved 7mm, compared with the predicted figures of 17mm and 13mm respectively.