CASE STUDY

GEOFEM

Welland Bio Power, Northants.

The £50 million Welland Bio Power Resource Recovery (10MW) centre in Northamptonshire, UK processes 60,000 tonnes of waste wood products every year into enough energy for 17,000 homes and saves about 28,000 tonnes of CO_2. But the settlement-sensitive M&E plant and variable ground conditions required some additional investigation and a high-powered foundation analysis.

AT A GLANCE

THE CHALLENGE

- Variable ground conditions causing differential settlements.
- Tight settlement and distortion limits on raft foundation due to sensitive machinery.
- Soil spring stiffness values needed for raft structural design.
- Earthworks nearby that might influence foundation settlement.

THE SOLUTION

- Recommended additional ground investigation to obtain improved ground stiffness values.
- 3D finite element analysis (FEA) model of the raft foundation, loading, supporting ground and adjacent earthworks.
- Predicted settlements were within acceptable levels for the proposed M&E plant, provided that the adjacent earthworks were modified.
- Coefficients of subgrade reaction (spring stiffness) provided to structural engineers for raft design.

THE BENEFITS

- The raft foundation option was accepted which saved about £500k compared with the piled foundation option.
- The raft structural design was optimised bringing further savings in time, cost and carbon.
- Potentially disruptive ground movements from the adjacent earthworks were avoided.

THE CHALLENGES

Avoiding a piled foundation solution for this new Bio Power Resource Recovery centre would save the project around £500k but several significant challenges needed to be overcome.

In particular, the proposed M&E plant for the facility imposed large, permanent loads on the foundations but was settlement-sensitive and up to only a 0.2% tilt could be tolerated.

Furthermore, the ground conditions were very variable, comprising predominately silts and sands in different proportions which led to very different ground stiffness and settlement rates across the building footprint, leading to differential settlement.

Major earthworks were needed to prepare the site leading to load changes on the adjacent ground larger than those from the building itself which would cause differential settlements of their own at the edge of the building footprint.

The structural engineers also needed subgrade reaction coefficients (spring stiffness) for the raft foundation structural design, but the concentrated loads, variable ground conditions and adjacent earthworks made these very difficult to estimate.

The Bio Power Resource Recovery centre

FULL ANALYSIS POWER

Additional ground investigation in the form of in situ CPTs was recommended to have more certainty in the spatial distribution of soil stiffness. This essential information was then transferred to the 3D finite element analysis (FEA) model of the raft foundation, loading and supporting ground.

Critically, this model also included the adjacent earthworks so that the ground movements from these and their effect on raft foundation differential settlement could also be predicted. Such interactions could only be simulated with advanced analysis methods such as FEA.

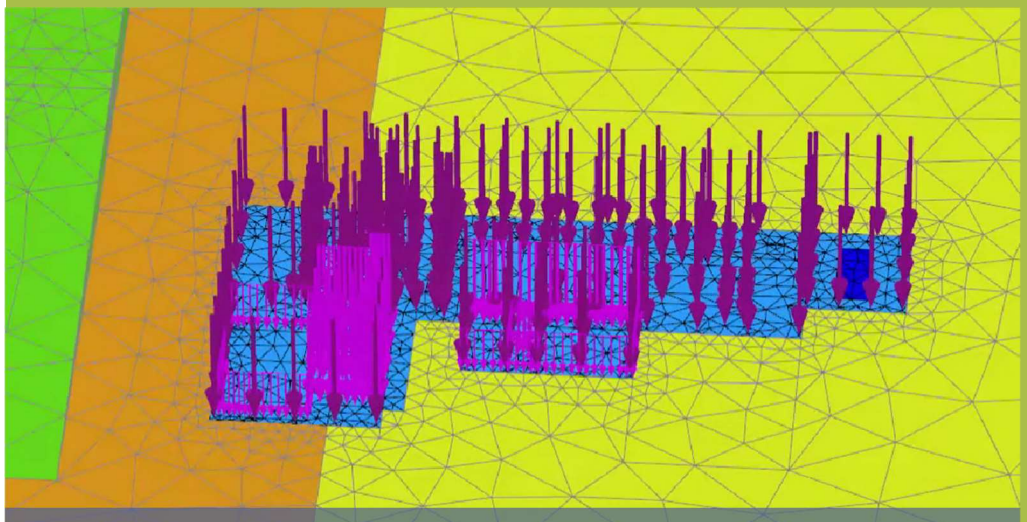
With the improved soil stiffness data, predicted settlements were found to be within acceptable levels for the proposed M&E plant.

The 3D FEA model outputs also included subgrade reaction coefficients and bending moment values that took full account of the variable ground conditions, raft stiffness and concentrated loads. These allowed a more accurate structural analysis of the raft foundation.

THE BENEFITS

Owing to the additional recommended site investigation and advanced geotechnical analysis, the raft foundation option was accepted, which saved about £500k over the piled foundation option as well as the associated additional time and CO_2 emissions.

The improved soil-structure interaction analysis of the raft foundation also allowed a more optimised design which brought further savings in time, cost and carbon due to reduced concrete and steel volumes.



3D FEA model of raft foundation, machinery loading and supporting ground

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