CASE STUDY

Robroyston, Glasgow

GEOFEM

Fleming Award finalist

"Geofem provided embankment settlement predictions for a range of geological scenarios, then measured the actual settlements by satellite to advise us that none of the pre-planned settlement mitigation measures were necessary. "

Craig Brodie, Senior Project Manager, Luddon Construction

Robroyston in Glasgow is undergoing significant development with a new railway station providing park and ride from the adjacent M80 motorway into the city, and plans for 1,600 new homes. A key element of the development was the construction of a link road between the existing M80 junction and the new station and car park.

AT A GLANCE

THE CHALLENGE

- Soft peat pockets needed deep ground improvement to support a new road embankment.
- Tensar proposed its much more cost effective Stratum solution but needed a way to predict differential settlement of the embankment.
- In situ monitoring techniques were sometimes damaged during construction or became inoperable over time.

THE SOLUTION

- From our R&D work for Tensar, we developed a peer-reviewed method of characterising the Stratum system in FEA.
- Both transverse and longitudinal differential settlement of the road due to the peat pockets was predicted by 3D FEA for a range of geological scenarios.
- Satellite InSAR data was analysed to provide post-construction embankment settlement data along the entire embankment length to complement or substitute for the in situ measurements.

THE BENEFITS

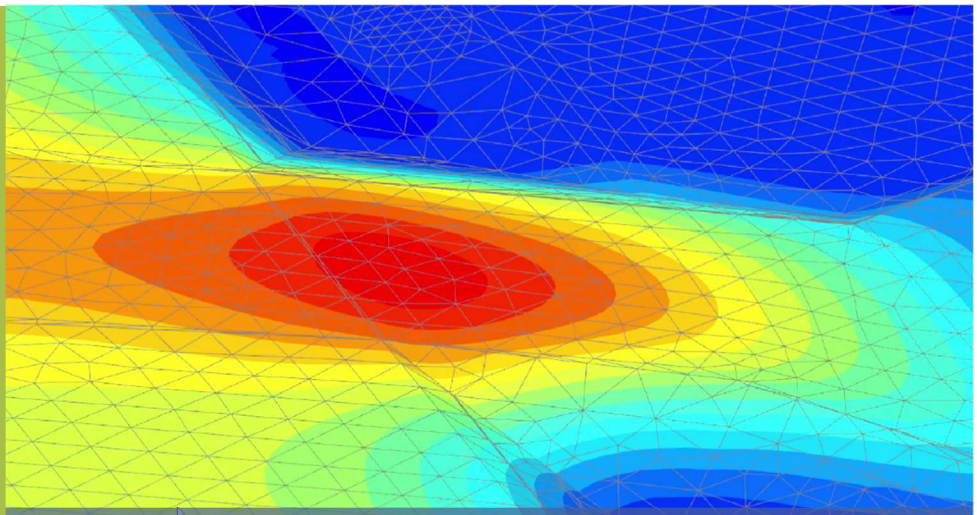
- The Stratum system was up to the job and saved Glasgow City Council £500k of deep ground improvement.
- The settlement predictions allowed Tensar to demonstrate the effectiveness of their proposed ground improvement solution for this specific site.
- Verification of performance of the constructed solution over the entire length without costly in situ surveys.

THE CHALLENGES

The ground conditions comprised variable made ground including an old ash tip and peat pockets which all required ground improvement of some form to prevent excessive differential settlement of the proposed highway embankment and unacceptable distortions to the road surface. Deep soil mixing and piling were considered but Tensar proposed the more cost-effective geocell mattress Stratum® system. However, predicting embankment settlements required a reliable means of simulating the Stratum system in finite element analysis (FEA).

Settlement monitoring both during and after construction were needed due to the uncertainty in the ground conditions, with pre-planned settlement mitigation measures in place had larger settlements than anticipated been recorded. Hydrostatic profile gauges (HPG) were installed at several locations to record foundation settlement but some were lost during construction and the data quality in the others gradually deteriorated post-construction.

A cost-effective means of obtaining settlement data both to substitute for the lost HPGs and to cover the entire embankment length was needed to have confidence that settlements were within the predicted ranges.



3D finite element analysis (FEA) prediction of embankment settlement

FEA & INSAR

Following an extensive review of the site investigation data, we devised a set of geological scenarios to consider rather than one single ground model due to the variability and uncertainty in ground conditions.

We prepared a 3D FEA model of the entire embankment to predict both transverse and longitudinal differential settlements, including those due to creep strains in the peat. The peer-reviewed Stratum characterisation method for FEA that we developed as part of our R&D work with Tensar allowed us to predict the performance of this ground improvement solution.

We analysed satellite InSAR data to provide post-construction embankment settlement data along the entire embankment length that both confirmed the HPG data and provided new information between the functioning HPG locations. These measurements also showed that settlements were within the ranges predicted for the different geological scenarios and we recommended that the settlement mitigation measures were not necessary.

THE BENEFITS & A FINALIST!

The Stratum system saved Glasgow City Council £500k compared with other deep ground improvement options, as well as having a lower environmental impact and being quicker to build.

Tensar were able to demonstrate the effectiveness of their proposed ground improvement solution for this specific site by scientifically rigorous methods.

Verification of performance of the constructed solution over the entire length without costly in situ surveys.

The project partners, including Geofem, were able to present the results of their collective efforts as finalists at the 2020 Fleming Award hosted by the British Geotechnical Association.

InSAR output of monitored embankment settlement in the months after construction

GEOFEM

Satellite analysis with engineering insight

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