VGO Deep Conversion Complex

Introduction

The project will increase the output of Euro-5 diesel fuel by 2.4 million tonnes per year (Mt/y). The scope includes installation of one of the largest hydrotreater units in the world with a capacity of 3.5 Mt/y and a 65% conversion ratio.

The unconverted residue will be used as a feed for the catalytic cracking and hydro catalytic units for producing high index base oils.

The sulphur content of the crude oils will be treated in a combined sulphur production unit, which includes sections for amine regeneration, sour water stripping, sulphur recovery, tail gas treatment and sulphur granulation.

The project is scheduled to be completed in 2015. The value of the TR's contract exceeds one billion Euros.

Scope of Work / Overview

- Arrangement of access permits and HSE training/certification in compliance with site requirements
- Supplemental geotechnical site investigation (10 BH’s to 30 m depth, 20 CPTU’s to 30 m depth, 5 SCPT’s to 25 m depth)
- Supplemental geotechnical laboratory testing according to GOST and ASTM standards (classification, shear box, triaxial shear, triaxial permeability, oedometer, double oedometer (subsidence) and various chemical testing of soil and water)
- Preparation of Factual Reports in English and Russian language in basic accordance with the valid GOST but also companion with ASTM standards
- Preparation of Interpretative / Engineering Reports incl. recommendations for site preparation, pile design, shallow foundations and road construction
- Consultancy and geotechnical engineering including 3-D Finite Element analysis for the optimization of the foundations / pile design, and bearing capacity and settlement calculations for piles and shallow foundations in accordance with Russian GOST and SNIP as well as international code requirements such as ISO, DIN and BS.
- Hydrological and hydrogeological study to evaluate the flood risk and potential for the site
- Preparation of specifications for site leveling, drainage, earth works, compaction and fill
- Preparation of specifications for a post construction test piling program in accordance with GOST 5686-94
- Supervision of site preparation, drainage, earth works, compaction and fill construction
- Supervision of test pile installation and pile testing
- Soil sampling and chemical analysis as part of an environmental baseline screening
- Establishment of an on-site laboratory for the performance of in-situ and laboratory testing for compaction control, including in-situ compaction and bearing capacity testing by means of in-situ density, water content, dynamic and static plate load testing
- Performance of compaction control testing
- Installation of infiltration wells for static pile load tests to be performed under saturation of the strata
- Installation of piezometers and ground water monitoring during and after construction

Vacuum Gasoil (VGO) Deep Conversion complex to be built within the existing LUKOIL refinery in Volgograd, Russia.

Project: VGO Deep Conversion Complex

Complementary Geotechnical Site Investigation

Consultancy and Supervision of piling and construction works

Location: LUKOIL refinery Volgogradneftepererabotka Volgograd, Russia

Client: TECNICAS REUNIDAS / INITEC PLANTAS INDUSTRIALES

Period: January 2013 – January 2014

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VGO Deep Conversion Complex

Project Overview

Initial geotechnical investigations were carried out by local Russian institutes on behalf of LUKOIL. These investigations indicated that the site was generally underlain by earth materials susceptible to both swelling and subsidence, although some data indicated that these risks were locally not present. This made development of safe and economical foundation solutions difficult.

Fugro was engaged by TR in 2012 to review the various geotechnical reports and provide recommendations for alternative foundations solutions. Based on that review, additional complimentary site investigation was conducted, a more robust ground model was developed, and alternative foundation solutions were developed and implemented to economically support the VGO process units and ancillary facilities whilst mitigating the risks of swelling and subsidence.

Technical Approach

Following review of the existing geotechnical data, Fugro engineers worked with the TR design team to develop a plan for obtaining additional data to better understand specific engineering properties and behavioral characteristics of the supporting soils, and to provide input for the detailed geotechnical analyses required for the foundation design. The additional data was also needed to meet the Russian code requirements regarding zonation of the subsoil and to fully utilize Russian state expertise in the process.

The site is near the Volga River in an area of potential flood risk. In addition to the risk of damage due to flooding itself, there was concern that inundation of the site could result in settlement and bearing capacity reduction as a result of saturation of collapsible soils.

Based on the investigation and analysis results it was concluded that flooding of the site would be unlikely to cause settlement or bearing capacity problems in the shallow subsurface, and thus most of the lighter structures could be founded on precast driven concrete piles of about 8 to 9 m length. However, a detailed interpretation of CPT and laboratory results indicated that there could be issues with deeper soil layers that would impact the foundations of heavier structures. To evaluate the behavior of the heavily loaded foundation elements a series of 3-D Finite Element analyses were carried out and an optimized deep foundation design was developed.

In accordance with the Russian design regulations, the deep foundation solution required the implementation of a Static Pile Load Testing program prior construction, and monitoring of ground water levels, soil saturation, and deformation both during and after construction. To further mitigate the risk, measures have been taken to inhibit the infiltration of rain, surface water flows, and any lateral ground water migration by installing concrete cover and sealing of equipment pads, and including surface and subsurface drainage systems.

Site preparation, fill and drainage construction, earth and piling works ran in parallel to the complementary site investigations, engineering evaluations, and design optimization effort. Fugro provided professional supervision with a bi-lingual Russian / English team to see that the design considerations and recommendations were implemented properly in construction. Fugro also supported the design and construction teams by preparing various specifications for the test piling program, excavation works, earth works, backfill and drainage construction, and by performing compaction control and in-situ density testing for fill and embankment construction, dynamic and static plate load testing, chemical testing and sampling for environmental screening, and settlement, deformation and ground water monitoring during and after construction.

Practical Solutions

FUGRO was asked to develop geotechnical engineering recommendations to assist TR in the design and construction of foundations to support the proposed structures. The VGO Deep Conversion Complex project represented a significant challenge – we mobilized state of the art digital CPT, SCPT and plate load testing equipment from Moscow and a team of Fugro engineers from throughout Europe. The Fugro team worked from multiple offices and at the project site, communicated throughout the assignment with TR design team which was based in Madrid and the civil team on site.

The application of state-of the art in-situ investigation techniques such as Fugro’s digital Cone Penetration Testing (which allows a better and higher resolution and stratigraphy identification than by using typical CPT equipment found in Russia), and the support of specialist engineers from the wider Fugro group brought significant benefit to the project and helped the client to realize an optimized and cost effective foundation concept. The performance of a series of full scale pile load tests while introducing water to saturate the critical soil layer provided an innovative way to quantify actual deep foundation performance and remove a critical uncertainty in the area of ground risk mitigation. The work was performed according to Russian SNiP & GOST, as well as to Western recognized standards.

An important element of this project was that the written and spoken elements of HSE activity and reporting and factual/ engineering reports were done in both the English and Russian languages.