Embankments on Piles

A421 Bedford to M1 Junction 13
Piled Supported Embankment Reinforced using Fortrac® M low strain Geogrids

Background Information

The A421 connects the M1, at junction 13, to the A1, at the Black Cat Roundabout, and is an important link connecting Oxford, Milton Keynes, Bedford and Cambridge. The existing A421 is being upgraded and comprises 8 miles (13km) of new dual two and three lane carriageway construction, between junction 13, on the M1, and the south side of Bedford (the Bedford Southern Bypass). The Highways Agency awarded this Early Contract Involvement (ECII) scheme to Balfour Beatty who, in turn, appointed Scott Wilson as their designer, in November 2005.

Site Challenge

Most of the new road was constructed 'off line', away from the existing A421, however due to alignment and access constraints the new road passed close to the existing road near a former quarry, and now landfill (Brogborough Landfill), and flooded former quarry (Brogborough Lake). The ground conditions in this location consisted of made ground with desiccated crust and soft clay, up to depths of 20 m, with undrained shear strengths of 15 kPa, increasing to around 50 kPa, at depth.

The road alignment in this location required the construction of embankments, varying in height from 1.5 m-7 m. If left untreated, the new embankments would result in considerable ongoing settlement, affecting traffic ride quality and consequential maintenance liability for the client. A variety of options were considered to support the road embankments in these locations, with a piled embankment deemed to provide the optimal solution providing both programme and cost certainties. Geosynthetic reinforcement is incorporated to bridge the tops of pile caps, distributing the weight of the new embankment and maximizing the economic benefits of piles installed in soft foundations.
The Solution

One of the principal design issues associated with geosynthetic reinforcement, spanning between piles, is that the mid span deflections associated with the reinforcement strain, are manageable, and occur during the embankment construction phase.

In order to limit these deflections, the design strain in the reinforcement was limited to 3%. The design assumes the entire load from the new embankment is either taken directly by the piles or distributed to the piles by the reinforcement, hence, long-term, the ground between the piles carries no additional load. To ensure this condition is reached, during construction, a compressible fill (processed compost) was placed between the pile caps, below the primary geosynthetic reinforcement layer.

The Fortrac® MP range of geogrids received BBA Certification for ‘basal reinforcement for embankment foundations’ in November 2008. The Fortrac® MP range of geogrids was specified by the designers as they provided the optimal stress/strain characteristics of high strength and low strain.

Four grades of Fortrac® MP (200, 400, 800, 1000 kN/m) were delivered to site in Autumn 2009. The completed section of road is due to open to traffic in late 2010.

The Advantages

- Immediate use of the embankment, without waiting for settlement to occur.
- Low maintenance: minimised deformation of the embankment after construction.
- Ability to use local cohesive fill material for embankment construction.
- Elimination of effects on adjacent components, e.g. pipes, foundations, etc.
- Fortrac® MP geogrids provided optimal design objectives of high strength and low strain.
- Customised roll lengths minimising waste.
- Economical solution providing cost and program certainties.

Location: A421, Bedford, England
Client: Highways Agency
Contractor: Balfour Beatty
Contractor’s designer: Scott Wilson
Construction: 2009
Products:
- Fortrac® R 200/30-30MP
- Fortrac® R 400/50-30MP
- Fortrac® R 800/100-30MP
- Fortrac® R 1000/100-30MP