Grouting

East Coast Main Line

COUNTY DURHAM

Emergency Grouting to stabilise railway embankment

Introduction

As a subcontractor to May Gurney Rail Structures Partnership (Network Rail/May Gurney JV), Bachy Soletanche Ltd (BSL) were employed to carry out remedial injection grouting to help stabilise a section of railway embankment on the East Coast main line in County Durham. The embankment had a history of instability since the 1970's and recent monitoring had led to a temporary speed restriction (TSR) been implemented, restricting trains to a maximum speed of 60mph. There had been previous unsuccessful attempts to improve the stability of the embankment by installing drainage to divert groundwater from the embankment and to grout up a culvert running through the embankment which was thought to have partially collapsed.

Design

In this latest phase, initial ground investigations did not uncover the extent of collapse of the culvert or the exact route of groundwater through the embankment although it was strongly suspected that the collapsed culvert was primary the cause of the local instability. The ideal solution would have been to remove the entire section of the

CLIENT:	Network Rail
MAIN CONTRACTOR:	May Gurney Rail Structures (Network Rail/May Gurney JV)
CONSULTING ENGINEER:	Donaldson Associates
DURATION OF WORKS:	5 weeks

WORKS QUANTITIES

TaMs installed	22 No.
Total Lm drilled	340 Lm
Total No. of lance holes	45 No.

BACHY SOLETANCHE

embankment and rebuild it but this wasn't an option as it was carrying the East Coast main line used by more than 300 trains daily. In conjunction with Donaldson Associates, BSL formulated a design whereby the collapsed culvert would be treated to stop further movement of the embankment and as a further measure; a grouted transition zone would be created in the overlying ash.

Tube a Manchette (TaM) Drilling

The solution was to use tube a manchettes, twenty two in total, installed at sub horizontal angles. The lower twelve were split into four rows of three with the middle four designed to intersect the collapsed culvert and the outer eight to treat the immediate surrounding strata. The top row consisted of ten manchettes to further consolidate the embankment directly beneath the track. A final treatment aimed to work together with the upper ten tams was to use lance grouting techniques, drilling down through the ballast into the ash and immediately injecting grout at 0.33m intervals, pulling back once grouting limits were met.

Drilling

A Klemm 804 rig was chosen to carry out the installation of the TaMs, working up from the lower rows. This was because a temporary working platform was needed for the rig to reach all levels of manchette installation, the platform being extended continuously throughout the duration of the project. All holes were drilled using casing and auger techniques with the temporary casings advanced in front of the augers to minimise any risk of further collapse. Once the drill depth was reached the casing was filled with a sleeve grout and the TaM installed. The casing was then withdrawn and additional sleeve grout injected through the tam to fill the space between the TaM and the soil.

Injection Grouting

Depending upon the strata, two types of OPC based grout were used during the injection grouting, each designed to influence the ground in differing ways. A grout with w/c = 0.7 was used to create small fractures in the underlying clay with a maximum of four litres per manchette sleeve injected to compact the soil. A more fluid mix was used for injections into the ash to allow permeation into any potential voids with a maximum volume of up to eighty litres per sleeve.

Injection grouters at work

The grouting was carried out using electro-hydraulic pumps, controlled by BSL's in-house grouting software (SPICE). The grouting instructions, containing the agreed injection parameters, are downloaded into the grouting computer. These instructions then automatically control grouting volumes, pressures and flow rates for individual sleeve injections. The grouting technician starts each individual injection via the computer which activates the grout pumps. The injection is automatically stopped when any of the pre-determined limits are met.

Monitoring

Throughout the drilling and grouting processes constant monitoring of track movement was carried out. A series of trigger levels were agreed with all parties and if any of the levels were reached an alarm was triggered in the grouting cabin and site office and the work would cease immediately. A careful review of the operation would then be carried out before proceeding.

Railside Working

Due to the sensitive nature of the works, the initial stages of both drilling and injection grouting were carried out under night time engineering possessions. Once the techniques employed were demonstrated as having no detrimental impact on the tracks the works were allowed to continue during week days. Since all the lancing works had to be carried out from the track bed the works could only be executed during weekend night time engineering possessions and the grouting operatives were all required to hold valid PTS cards.