The Periglacial Legacy:
Landslide Stabilisation on the M25

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Introduction

M25 J6 Flint Hall Farm Cutting
• 19-20th Dec 2000: Major landslide on N side of M25
• Gault Clay cutting only 11 degrees
• Effected hard shoulder and adjacent over-bridge
• Potential to cause closure of anticlockwise carriageway
• Need for fast track approach

Introduction: Plan of site

Landslide Morphology

Backscar Toe bulge
Tensional zone beneath the bridge – graben structure
Hard shoulder heave

Post construction monitoring on the M25

The Periglacial Legacy:
Geological Setting

- Gault part of N Downs escarpment
- Very stiff grey fissured silty clay
- Deposited in deeper water during marine transgression
- Subsequently mantled by Chalk UGS

Periglacial Processes

- Literally 'around the glacier'
- Cold climate features due to intense frost action
- Cryoturbation – mixing of soil layers during freeze thaw
- Solifluction – downslope movement of saturated soils
- Development of shear surfaces
- Deposition of sandy debris
- Subsidence

Previous Failures

- Below: Soils and Materials Report, 1976 (pre construction)
- Right: Failure surfaces found during construction

Investigation & Monitoring

- Immediate actions:
  - Traffic management
  - Alarm system
  - Contingency planning
  - Low tech slope monitoring
  - Emergency drainage
- Geomorphological mapping
- Multiphase GI
- Instrumentation

Soils and Materials Report, 1976

Summary of Geomorphology

- Surface features, Desk Study, 1991
- Air photo study, Desk Study, 1991
- 2001 air photo & mapping studies

Geological Setting
Investigation

- Identify ground conditions and mechanism
- Confirm extent of failure
- Quantify risk to properties

Detailed Soil Logging

- Only possible in shored pits
- Allowed identification of:
  - Gault / Head interface
  - Ice wedges
  - Desiccation cracks

Monitoring

- 15 no. inclinometers
- 34 no. standpipe and 2 no. vw piezometers
- 34 No. slip indicators
- Bridge monitoring: tiltmeter, crackmeter, temperature, surveying

Geological Model

- Design process:
  - Properties based on lab testing, literature & back analysis
  - 60 year design life meant structure solution required
  - Pile to provide 20% increase in FoS, plus help prevent
  - Drainage to further improve FoS, plus help prevent instability above and below pile line

Design Process II

- Establish restoring force and drainage required to achieve desired factor of safety
- Calculate pile size, length, spacing and determine required position within slip

Investigation

- Identify ground conditions and mechanism
- Confirm extent of failure
- Quantify risk to properties
Construction Contract Strategy

- Work carried out by RCS under ECC Option E ("cost plus")
- Allowed easy adjustments to design if required
- Highways Agency carried all the ground and weather risk
- Risk priced into contract and money released as risk reduced
- Project complete on time and 30% below budget at £2.8m
- All works complete within one year

Construction Observations

-10.00 -8.00 -6.00 -4.00 -2.00 26-Sep-01 26-Oct-01 25-Nov-01
Ground Water Level (m bgl)

BH22A
BH22B
BH23B

-16.00 -14.00 -12.00
Ground Water Level (m bgl)

BH23B
daily rainfall

Post Construction Monitoring

- Residual risk management by continued monitoring
- Inclinometers within piles and slopes, piezometers,
monitored by TRL as part of HA research programme
Mobilisation during First Winter

Summer 2001
Spring 2001
BH4 Mid Slope Borehole Pile Bending Moments

Design

Winter 01/02
Actual, Oct 01

Long Term Monitoring

• Sub-hydrostratic pwp due to effective drainage
• Small seasonal movement on BH4 upslope
• Most monitoring ceased 2006
• TRL monitoring later reinstated

Failure

Ongoing Management

• Flint Hall Farm just one location of this stretch of M25 and M26 which requires ongoing risk management.
• Adjacent instrumentation at Rook’s Nest Farm continues to show small shear movements.
• Important Gault corridor landslide risk study by Mouchel
• The North Downs escarpment has suffered periglacial slope instability
• One such fossil landslide reactivated during the very wet winter of 2000/2001
• Movements were driven by high pore water pressures

Summary

• Movements were driven by high pore water pressures
• Stabilisation was achieved through a combination of piling and drainage
• Post construction monitoring has shown the remedial measures to be effective
• However, adjacent areas remain at risk and subject to ongoing management

References


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