Stabilisation of landslip using pile retaining wall solution

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BRI 2006
12th October, Dublin
Stanton Lees, Derbyshire, UK

Embankment, 90m in length, slope 35–40°

Longstanding problem of instability, particularly after periods of heavy rainfall

Significant movement
Nov 2000 and Feb 2002
Embankment supporting existing gabion retaining wall slipped 0.5–1.0 m
Rainfall Data

Daily data, Middleton, Derbyshire

Autumn 2000, wettest season since local records began in 1870
Oct. 2000 yielded 209% mean monthly rainfall for that month, second wettest on record
Survey data

Ground movement and groundwater levels monitored over 14 month period

Hilti nails in road surface and four lines of wooden pegs driven in embankment

Movement coincides with high total rainfall figures

No distress in northern part of road

Survey points at road level
Ground investigation

19 boreholes and seven trial pits
Standpipe piezometers, groundwater recorded in all instruments

KEY

A  Granular Fill
B  Cohesive Fill
C  Very soft, soft and soft to firm CLAY/SILT HEAD
D  Firm and 'Dry Friable' CLAY HEAD
E  Completely to highly weathered SANDSTONE
F  Moderately weathered SANDSTONE
G  Completely to highly weathered MUDDSTONE/SILTSTONE
H  Highly to moderately weathered MUDDSTONE/SILTSTONE
Stability back-analysis and sensitivity study using Slope/W assuming FOS of unity (limiting equilibrium) applies

Soil parameters: preliminary soil parameters from ground investigation and laboratory tests

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Bulk unit weight (kN/m³)</th>
<th>Effective stress parameters</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>c' (kPa)</td>
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<tr>
<td>Granular fill</td>
<td>17</td>
<td>0</td>
</tr>
<tr>
<td>Cohesive fill</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>Head material (peak)</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Completely to highly weathered sandstone</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Completely weathered mudstone/siltstone (peak)</td>
<td>21</td>
<td>5</td>
</tr>
<tr>
<td>Competent bedrock</td>
<td>23</td>
<td>50</td>
</tr>
</tbody>
</table>
Remedial works

Replace gabion wall with cantilevered bored pile retaining wall

Analyzed using WALLAP and Burland-Potts method

Design groundwater levels = highest observed plus 1.5 m head behind wall

Friction $\delta/\phi = 0.66$ considered in deriving full active and net available passive earth pressures

Failed groundmass on passive side provide surcharge only to underlying weathered rock
Two rows, 600-mm dia. bored piles (86 in total) installed along southern road verge staggered in plan, clear spacing 1.0–1.7 pile diameters, allows free passage of groundwater 8.0–13.5 m in length, founded within underlying mudstone and sandstone bedrock reinforced-concrete capping beam connecting pile heads

25-tonne compact Bauer rig
Acknowledgements

Derbyshire County Council Consulting Engineers kindly acknowledged for granting permission to publish case study

THANK YOU