RGS

Environmental
Geotechnical
Specialists

COMPREHENSIVE GEOTECHNICAL & ENVIRONMENTAL ENGINEERING SERVICES
DELIVERED USING OUR OWN DRILLING RIGS / CREWS / SOILS LAB / ENGINEERS

CASE STUDY 05

A Tale of **Three Slopes**

// INVESTIGATION AIMS

A modern management idiom claims there are no such things as problems, only solutions. This is not the case in geotechnical engineering, where a solution can only be formulated after all of the problems are fully understood.

This was demonstrated in three separate investigations of failed slopes conducted in the past two years; two in East Yorkshire, one in North Yorkshire. Each case involved the stability of river banks within the rear gardens.

Investigating the causes of failed slopes
The impact of river bank stability.

// FINDINGS

For Case 1 the site was shown to be underlain by Glaciofluvial deposits comprising fine and medium sand over very silty fine sand.

For cases 2 and 3, the superficial deposits were noted to be the Breighton Sand Formation which consisted of very silty clay grading into clayey silt, which became laminated with fine sand at depth.

In all three cases the slopes between the houses and the river/dyke were failing, with rotational movement of the slopes being evident. Moreover, the presence of the water courses, all of which are prone to flooding, the topography of the river banks and the strata conditions were strikingly similar. Therefore, at first sight, it would seem likely that there would be a common link for the observed slope instability.

However, in the event it was shown that the actual triggers for the three failures were quite different.

// PROJECT SPECIFICATION

The investigations comprised undertaking boreholes and dynamic probes (DPSH) using one of RGS' small windowless sampling drilling rigs, geotechnical laboratory testing in the RGS in-house soils lab, together with hand augers, careful visual inspections by one of our engineers and desk based analysis and calculations.

- Cases 1 and 2 were on the outside of bends on the River Ure (1) and River Wharfe (2). At both locations there was a narrow alluvial flood plain and a river bank up to the subject properties, which were situated on higher ground.

  In both cases, levees had been constructed on the opposite side of the river which channelised flow and protected the adjacent floodplain.

- Case 3 was associated with the back gardens of three properties that had been constructed on a flood bank, which slopes down to a berm then down to a flood alleviation dyke, which enters the River Wharfe via a sluice.

// FINDINGS

Case 1: The trigger for failure was the presence of the levee on the opposite side of the river as this increased the level of water during flood episodes. As the underlying soils are permeable in nature, water was able to enter the slope.

When the flood level subsequently reduced, water flow through the very silty fine sand resulted in a phenomenon known as running sand, thus toe support to the slope was gradually removed such that slumping and progressive failure of the slope occurred, which regressed up the slope.

The recommended remediation included the construction of a sheet piled retaining wall along the river bank and to protect the toe of the slope to reduce the risk of erosion.

Case 2: At this site, the more sensitive fine granular soils were present beneath a capping of less permeable soil, comprising very silty clay. Therefore, the groundwater regime would not be adversely affected by short term flood episodes. However, at this site it was known that a water main had burst and the water was entering the underlying silts via a gully, which resulted in an imbalance in the groundwater profile and failure of the otherwise marginally stable bank ensued.

At the onset of movement, tension cracks developed through the more cohesive soils, thus during future periods of high water the underlying more sensitive silts could be adversely affected by inflowing water. In this case the remediation included the removal of the source of groundwater by properly constructing the outfall from the gully.

Re-grading the bank by the addition of coarse granular soils to resist erosion and possibly soil nailing to assist in the stabilisation of the slope.

// PROJECT SPECIFICATION

Case 3: Similar soils were present at this site and it was known that a surface water outfall pipe between two of the properties had failed. This would suggest a similar mechanism for failure as Case 2. However, at this site there was a timber king post wall supporting the bank of the dyke.

// OUTCOME

The RGS team established that this retaining structure was under-designed and therefore consequently failed, which caused the slope to move, which in turn caused the pipe to fail.

Clearly, the remediation required at this site would include stabilising the dyke bank by the construction of a suitable retaining structure.

Tension cracks within the berm should then be infilled with low permeability soil and the damaged outfall pipe should be repaired.

Our range of services is extensive. We can assist in many ways, **whatever stage your project is at**. So please **don't hesitate** to pick up the phone and speak to us if you require any assistance, advice or information.

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