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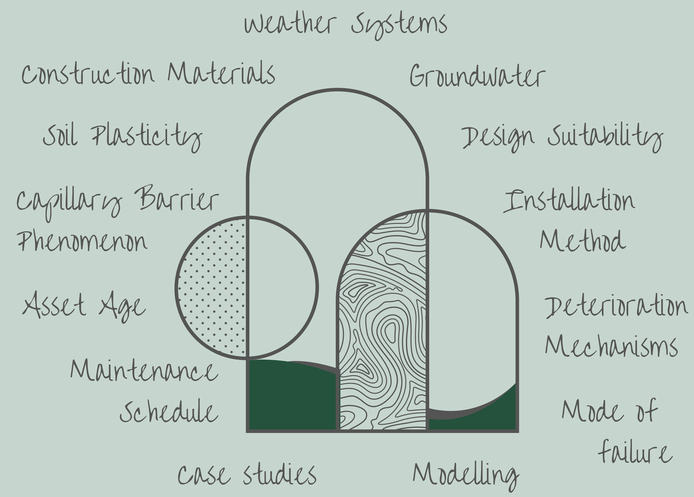
CLIMATE CHANGE IMPACT ON SLOPE STABILITY: A STUDY OF DRAINAGE TRENCH DESIGN AND INSTALLATION

Elena Mugarza, Professor Stephanie Glendinning,
Dr Ross Stirling, Dr Colin Davie.



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ADDRESSING INFRASTRUCTURE'S ACHILLES HEEL

Newcastle University

National Green Infrastructure Facility

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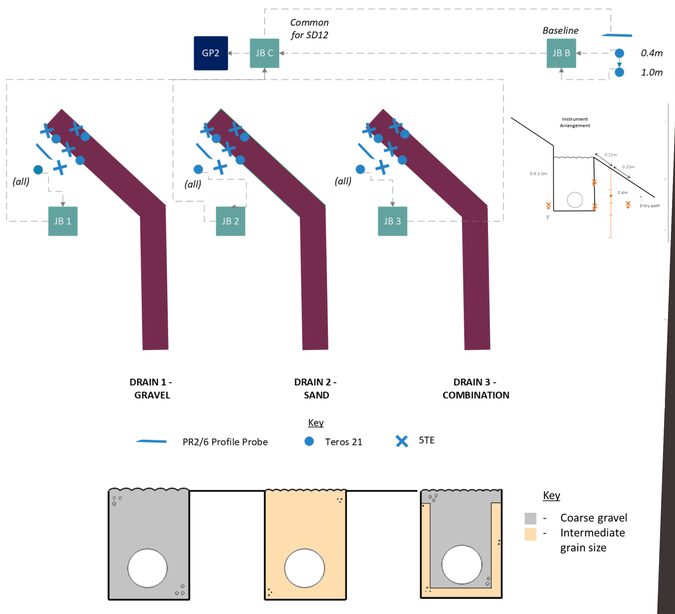
Transportation slopes across the UK are vulnerable to climate change and exposure to increasingly frequent inclement weather. In recent years many of these slope failures have gained national press attention for the disruption they cause to essential transport links and the public spend required to repair and reinstate. Compacted clay soils, commonly used in the construction of embankments in the transport infrastructure sector, are subject to progressive deterioration caused by volumetric shrinking and swelling, in response to wetting and drying weather cycles. Precipitation events in Britain are expected to worsen in frequency and severity during the next decade. The provision of slope drainage is considered to be a critical intervention method for existing infrastructure slopes, to improve their resilience to rainfall events and to reduce the rate of future deterioration. However, the effectiveness of such drainage solutions is dependent upon their ability to reduce pore water pressures within the slope, by providing a preferential flow path for the water and discharging into an effective drainage system. Drainage installation methods and their upkeep are vital components in ensuring that the asset remains operational, as opposed to either progressively clogging with fine-grained materials or allowing deeper and faster propagation of wetting fronts, causing degradation at depth. This project will present an investigation into the impacts of trench design, installation methods, and several months of UK winter weather on the performance of granular drains. This will be evaluated through the monitoring of soil suction and moisture data from three true-to-scale drainage trenches of varying composition, installed with a full-scale test embankment constructed within medium plasticity clay.

Project Scope - Field

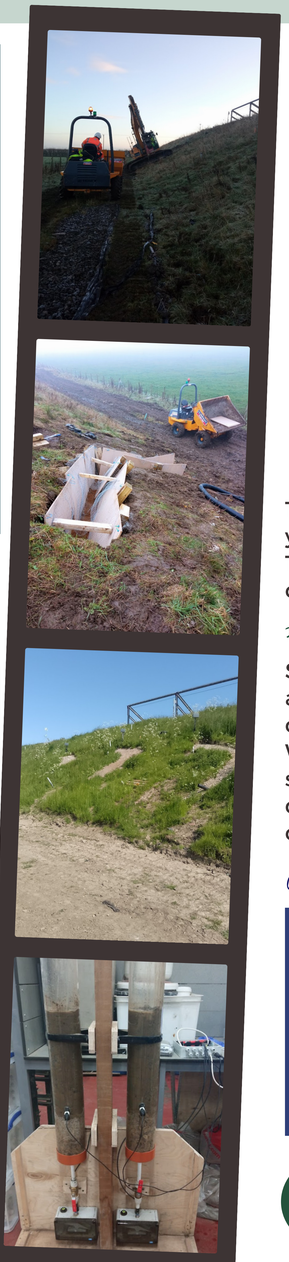
This project includes the installation of three herringbone-style slope trenches at the BIONICS embankment, for the purpose of monitoring and analysis. The first trench is designed to replicate that in place on highways and rail assets. The second and third trenches differ, giving consideration to the capillary barrier phenomenon that is considered to be one of the contributing factors to ineffective slope drains. These include the use of sand as an 'intermediate grain size' soil, theoretically encouraging the infiltration between drains and the surrounding ground. Instruments to monitor the soil's suction, temperature and moisture content have been installed at varying depths and distances to enable understanding of the surrounding soil behaviours.

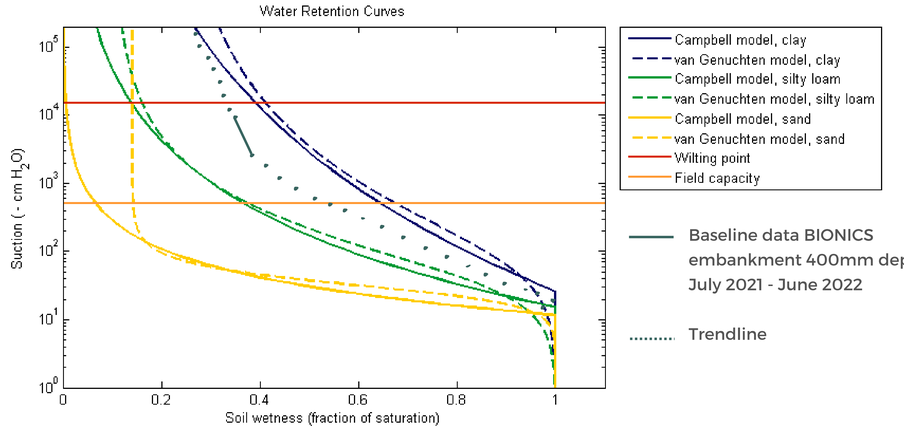
Capillary Barriers

A capillary barrier originates in unsaturated conditions when a finer-grained soil sits adjacent to a more permeable coarse soil. Infiltration of water is limited due to capillary tension. The coarser layer is non-conductive at high suction. This can have a detrimental effect on slope drainage, when compacted clay surround very coarse infiltration material. Material choices should be closely considered.



*Materials chosen for infiltration include a 40/20mm shingle and readily available sharp sand.





The Soil Water Retention Curve above shows the trendline taken from baseline instruments, one year prior to drain installation. This is reflective of the glacial tills used to construct the embankment. There was found to be little variation is the suction or moisture content throughout the year weather cycle at 400mm depth, without the presence of drainage, to promote preferential pathways.

Project Scope - Laboratory

Soil column experiments are also being conducted in the lab, to evaluate the different drainage arrangements and deterioration associated with the presence or absence of geotextiles. These comprise 300mm layers of the granular soil(s) overlain by 600mm samples of embankment clays.. Water is periodically added, to reflect a 1 in 100 year + 40% storm event. This may also be repeated, to simulate cyclic wetting and drying of these soils and their response to extreme rainfall, in their desiccated state. Soil classification testing will help to distinguish behavioural differences between clays used for embankment construction.

Case Study review

To aid increased understanding of installation and deterioration challenges, faced by the asset holders, inspections of real life drainage case studies will be conducted. This will include new installations and aging assets, in both rail and highway applications. A desk top review of incident reports and procedural guidance will also help to paint a clear picture of current industry norms.

e.mugarza@ncl.ac.uk @elenamugarza