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The influence of extreme wet weather on railway embankment hydrology

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During the winter of 2000/2001 the UK experienced the wettest weather since records began in 1766, which followed a wetter than average summer. This period of sustained wet weather contributed to higher than average soil water content and pore water pressures, resulting in about 60 slope failures on the roads and more than 100 failures on railways across the UK. Embankment instability during extreme weather is of concern to rail infrastructure owners, and there is a need to develop a better understanding of earthworks subject to adverse weather.

Following the wet winter of 2000/2001, a programme of pore water pressure monitoring was carried out on railway cuttings and embankments across London by the metro operator London Underground Ltd. Due to the preceding period of extreme wet winter, pore water pressures would have been at their historical maximum (for the life of the earthwork) during the monitoring period. In some instances hydrostatic pressures were measured, however a significant number of measurements were below hydrostatic and some negative pore water pressures were measured.

The objective of this work has been (1) to re-examine the monitoring data measured following the wet winter of 2000/2001 to understand the factors contributing to the range of pore water pressures measured; and (2) to describe a range of factors which should be considered when assessing pore water pressures for design and assessment purposes.

The monitoring data, consisting of 113 no. piezometer measurements across the London Underground Ltd network, were compared with records providing supplementary information about 82 of the 113 piezometer locations. Information was obtained relating to embankment location, geometry, geology, remediation history and the presence of slope vegetation.

A correlation was found between measured pore water pressures and the permeability of the embankment foundation, which varies across the London Underground Ltd network. Embankments in areas of Chalk and Terrace Gravel, and therefore founded in high permeability material, maintained low pore water pressures (<15 kPa) throughout the clay fill. In areas of London Clay, higher pore water pressures close to hydrostatic were measured. Numerical modelling of transient water flow in response to a climate boundary condition using daily weather data measured during the winter of 2000/2001 supports this conclusion. This has been used to explore the relationship between weather extremes, clay fill permeability and foundation permeability on maximum pore water pressures.