DISAGGREGATION OF SOIL DURING SLURRY PIPE JACKING

by

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ABSTRACT

Pipe jacking is an environmentally friendly technique for the installation of services and utilities, which leads to minimum disturbance during installation. It is an important construction method for urban environments where disruption to transport is expensive. The need to tunnel through varying geologies requiring support during tunnelling has led to the increased use of slurry tunnel boring machines. The slurry is used to stabilise the tunnel face and transport the excavated spoil to the surface.

The research detailed in this dissertation assesses the magnitude of soil disaggregation during the excavation and pumping of the arisings within the slurry to the separation plant. The two main objectives were to create a mixing test that would allow the disaggregation of the soil to be predicted prior to specification of the separation plant and to link the results of this test to typical soil properties. In addressing the second objective efforts have also been made to characterise the different mechanisms of disaggregation observed in the mixing tests. The typical soil testing methods used to classify the soil samples were; Atterberg limits, particle size distributions, unconfined compressive strength, mineralogy (XRD) and chemical analysis (XRF).

A mixing test has been designed using a Hobart planetary mixer to classify the amount of soil cuttings that disaggregate during mixing with a slurry fluid. This test was found to produce repeatable results using Speswhite Kaolin samples and then used to assess the differences in disaggregation rates of London Clay, Upper Mottled Beds and Fleetwood Silts. In total 71 mixing tests were completed during the development of the test and the classifying of the soils. The test involved mixing distilled water with 10 clay cuttings for varying times. The resulting solid particles were then sized through a series of sieves and sedimentation tests carried out to produce a particle size distribution of the resulting soil.

The mixing tests showed the Upper Mottled Beds to have the highest rate of disaggregation, with the Fleetwood Silts displaying the least. This has been attributed to the level of cementing within the soil and the microstructure of the clay and silt sized particles.

The liquidity index and initial soil strength were not found to be important factors in the predicting the rate of disaggregation of a particular soil type, but were significant for some soils. The Fleetwood Silts had the lowest unconfined compressive strengths but also produced the least amount of disaggregated soil. The soil macrofabric, although not quantified, also appeared to have an effect on the rate of disaggregation of a particular soil. An increase in discontinuities within the sample produced more cuttings larger than 4.75 mm but a lower amount of 63 μm sized fraction disaggregated.

In addition to the mixing tests carried out using water, a series of tests were completed using a polymer based slurry, HydroCut CF. This showed mixed results; The polymer prevented any clay or silt sized particles from passing through the 63 μm sieve. However, there was no overall reduction in disaggregation and a significant increase in the time it took to sieve the slurry.