Improvement of erodibility of a sand (sandy soils) treated by microbially induced urea-based carbonate precipitation

L. Oxarango, E. François-Lopez & H. Mora
Univ. Grenoble Alpes, CNRS, IRD, Grenoble INP, IGE, F-38000 Grenoble, France

R. Béguin[1] & A. Esnault-Filet[2]
[1]geophyConsult, 159 quai des allobroges, 73000 Chambéry, France,
[2]Soletanche-Bachy, 280 Avenue Napoléon Bonaparte 92500 Rueil Malmaison, France

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In France, the ageing of earth dikes result in a strong interest in cost-effective (innovative) soil reinforcement methods. The main objective is to maintain the stability of the structure by preventing mechanical failure due to internal erosion or liquefaction. Microbially induced urea-based carbonate precipitation is emerging as a potential method. This kind of process is generally based on two sequential steps: i/ the injection and filtration of a suspension of specific bacteria in the soil to be treated, ii/ the injection and reaction of a reactive solution. In appropriate operating conditions, this process leads to the binding of soil grains by carbonate crystals and consequently improves the erodibility of sand.

First, this study aims at characterizing the benefit of such a process with respect to contact erosion mechanisms. A set of Contact Erosion Tests (CET, Guidoux et al 2010) has been performed on treated Fontainebleau sand with calcite content between 0% and 7%. The untreated material shows a high sensitivity to contact erosion with a critical flow velocity of 10^{-2} m/s. A strong improvement of the erodibility was obtained for calcite contains higher than 2% since no erosion was observed at the apparatus maximum flow rate (corresponding to a flow velocity of 6.5 10^{-2} m/s). The benefit of the method for sand containing calcite contents lower than 2% is questionable since the treatment appeared to be heterogeneous.

Second, Hole Erosion Test (HET) and Jet Erosion Test (JET) have been performed on the Fontainebleau sand with different calcite contents. Both tests show that the treatment improved the erodibility of the sand. The treated material is "Resistant" in the classification proposed by Hanson and Cook (2004) for JET results in comparison with a classification "Very erodible" for the untreated material. HET could not be performed on the untreated material due to initial collapse of the sample, but treated material could be tested and is classified with an erosion velocity of "Moderately rapid" according to Wan and Fell (2004) classification.

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