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Application of Biogeotechnice for Dust Control of Sand

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Abstract

Dust is an environmental hazard due to soil loss and air and water pollution. There are a number of biological and chemical methods for the stabilization of exposed soil surfaces by aggregation of fine particles and reduction of the rate of aggregate loss. These conventional soil improvement techniques – including both mechanical and chemical stabilization methods – have potential drawbacks such as high cost, high energy consumption and sometimes negative environmental influences. However, the rapid development of biotechnology has provided opportunities for innovation in soil improvement methods. In recent years, a promising approach, the so-called microbial geo-technology, has been attempted. Using the microbially induced carbonate precipitation (MICP) process, calcium carbonate can be generated and used to increase the shear strength of soil. Thus, the study of the use of biocement for dust control and wind erosion was carried out using a wind tunnel. The surface of sand on the model tests was sprayed using biocement solution of different concentrations. The model was put in the wind tunnel and the change in the soil mass of the soil model after subjecting to a horizontal wind. Similar tests on soil treated using calcium chloride solution and water were also carried out for comparison. The test data show that the rate of mass losses for bio-treated sand with a calcium carbonate to sand ratio of 0.1% (w/w) decreased by 85% 14 days after treatment.

Keywords: Biogeotechnics, Dust, Sand.

1. INTRODUCTION

Dust is an environmental hazard. Dust that is commonly encountered includes dust from agricultural fields, road beds, disturbed land, mineral extraction and construction and industrial sites. Ground erosion by wind and dust generation from unpaved roads, dune movement in deserts, dust storms in arid and semi-arid lands as well as the emissions and dispersion of agriculture, construction, transportation and mining are a serious environmental concern due to soil loss and air and water pollution. There are a number of biological and chemical methods for the stabilization of exposed soil surfaces by aggregation of fine particles and reduction of the rate of aggregate loss. Some patents have been issued on methods to control wind erosion of soil and dust suppression. Piechota et al. (2004) defined the "effectiveness" of dust suppressants as the ability to maintain soil particles on the surface under erosive forces, such as wind. However, common dust suppressants have disadvantages such as high cost, short-lived results, environmental toxicity (negative effect on plants and water pollution), high equipment maintenance, leaching with rain, corrosivity, etc. Therefore, there is a need to develop new methods for dust control. An alternative method for dust suppression is biocementation using non-pathogenic and urealytic bacteria with calcium chloride and urea solution [2, 3, 4, 6 and 7]. Biocementation is based on the precipitation or crystallization of insoluble compounds in porous soil using the enzymatic activity of microorganisms. Several experimental studies have been performed using biocement for sand dust suppression [2, 3, 7 and 8]. However, more research is required.

Piechota et al. stated that a “crusted surface” - even with a weak crust - significantly reduces the rate of erosion and, subsequently, can bind fine particles and suppress dust. The conventional methods for controlling dust can be classified as follows: a) agronomic methods (consisting of establishing vegetative cover), b) surface penetration methods, c) admixture methods (consisting of synthetic polymer products and biopolymers) and d) surface blanket methods (consisting of aggregates, prefabricated membranes or meshes and bituminous). The limitations and advantages of the common surface penetration methods indicate there are many factors to consider when selecting a dust control method. The ideal method should be environmentally compatible, easily applied, require minimal maintenance equipment, reasonably effective at