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Effects of biological soil improvement method on leakage of waste leachate from engineering landfill liners

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Abstract

Biological soil stabilization is a new and environment friendly method of soil improvement. In this method the urease activity of a bacteria cause the precipitation of the calcium carbonate in the soil medium. This method has been performed by injection of solutions to the soil which are contained the needed materials for initiating the process. Besides the soil properties such as soil grading, porosity, etc., the cementation solution properties affects the obtained results of this method. The latter properties include injection method, solution concentration and PH. As a result, this process causes the bounding of the soil grains. Another important result of the mentioned method is decreasing the permeability of the soil. In the present paper, an engineering landfill liner is modeled by SEEP/W software to evaluate the effect of the biological soil improvement method on controlling the leakage of the waste liquids around these landfills.

Keywords: Soil improvement, biological method, permeability, cementation solution, landfill liner.

۱. INTRODUCTION

When wet wastes are dumped in a waste disposal, a viscous liquid is leached as time is lapsed. This liquid which consists of numerous and usually toxic elements is called leachate [۱,۲]. Leachate flows through the wastes and gather at the bottom of the landfill. Therefore huge amount of this dangerous liquid will be in contact with the soil layer beneath the landfill. This accumulated leachate is penetrated through the beneath soil layers by different mechanisms and eventually enters the aquifer. Increase of the concentration of these materials may exceeds the available standards, hence the aquifer become toxic. To prevent the mentioned process in landfills, different engineered layers are constructed [۳,٤]. CCL liners are usually used as the leachate barrier system in the solid waste disposal facilities because of their low permeability and adequate compactibility and strength. However, shrinkage cracks may appear in the clayey liners and cause the seepage of the leachate and therefore decreasing the efficiency of the landfills through their lifetime [٥]. Hence, in this paper the clayey landfill is replaced by a biologically improved soil system to evaluate the efficiency of the proposed system as leachate barrier system against the advection mechanism.

۲. BIOLOGICAL SOIL IMPROVEMENT:

A new grouting material, biogrout, has been developed in recent years [٦,۷,۸]. Biogrout has low viscosity in solution and thus can penetrate better than cement or chemical grouts. The other advantages of biogrout over dissolved organic grouts are lower cost and lower toxicity [۷]. Bioclogging is a process of filling the pores in soil with minerals and other substances that are generated microbially to reduce the soil permeability. Biocementation is a process to bind soil particles together with minerals and other substances to increase the compressive strength of soil. A common process for bioclogging and biocementation is microbially induced carbonate precipitation (MICP). As bioclogging and biocementation take place simultaneously most of the time, the two terms are used to refer to mainly the purposes of applications rather than the processes in practice. MICP can be either a natural or engineered process that is controlled by different factors and through different mechanisms [۹]. One of them is the production of calcite in the porous soil by urease-