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Proposing a New Approach to Assess Suffusion Phenomenon Based on Physical Properties of Soil

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Abstract

Suffusion is the moving of soil particles through the soil body. The grain size distribution and porosity of soils are the most important factors that influence on suffusion process. Up to now, many methods have been proposed to predict suffusion which the validation of them are less clear because most available criteria are based on tests on limited soils.

In this research some exiting methods developed based on soil porosity have been investigated. Some samples of soil with different porosity and aggregation have been selected and suffusion possibility is estimated for them by use of the exiting criteria. Based on results, these methods are slightly unconservative to evaluate suffusion. Some samples are recognized stable, whereas they are experienced suffusion and vice versa. Finally, statistically analyses have been developed to modify these methods based on physical properties of soil.

Keywords: Suffusion, Soil Porosity, Relative Density, Statistically Analysis.

1. INTRODUCTION

Internal erosion of soil structures is an essential problem for long-term stability of earth structures impacted by seepage. One particular phenomenon of internal erosion is called suffusion. Soils which are susceptible to suffusion are internally unstable. In suffusion the fine particles are removed through the voids between the larger particles by seepage flow, left behind an intact soil skeleton formed by the coarser particles. Soil with gap-graded or concave aggregation can be susceptible to suffusion. Due to the fact that, the porosity in coarse particles allow to erode fine particles. The cohesiveness and compaction of soil is also effective to soil instability, so that increasing of them lead soil to stable condition. By and large, understanding of the suffusion process is important to the assessment of the risk of internal erosion in earth structures.

Suffusion is a complicated phenomenon that influenced by many factors such soil aggregation, porosity, effective stress, the cohesiveness of soil particles and seepage forces within the soil. Many experimental and theoretical studies have been done to determine the vulnerable soil to suffusion. Different approaches suggested to identify suffusive soil are divided to geometric and hydraulic criteria. Diameter of any soil grain, the factor of uniformity (Cu) and soils porosity are the basic inputs used in geometric available criteria. Diameter of soil grain currently uses in all geometric criteria. But, the other two especially porosity of soils seldom utilize in proposed approaches. USACE (1953), Isotomina (1957), Patrasev(1957), B. E. Vedeneev VNIIG (1961) Ziems (1969) ,Kenny and Lau (1985) and (1986), Burenkova (1993), Wan and Fell (2004a) and (2004b), Li and Fannin (2008) have been developed several geometric methods to recognize internal erosion and Kezdi (1979), Sherard (1979), Foster and Fell (2001) have proposed the geometric criterion to assess self-filtering in soils. But, the comparison of the available approaches shows that in general they are restricted in their usability. Mostly the limitation related to Cu or the gradation, because the empirical criteria are limited to a range of soils and don't generalize for any kind of soils.

Since, the majority of recommended approaches are based on geometric condition. This paper focuses on the performance of some geometric methods developed based on every three parameters of soils porosity, aggregation and Cu. Some samples of soil with different porosity and aggregation have been selected and suffusion possibility is estimated for them by use of the selected criteria. Based on results, these methods are unconservative to evaluate suffusion. Some samples are recognized stable, whereas they are experienced suffusion and vice versa. Finally, statistically analyses have been developed to modify these methods based on physical consideration.

2. PROPERTIES OF SOIL SAMPLES