Procedia Engineering

Volume 143, 2016, Pages 98–103

Advances in Transportation Geotechnics 3 . The 3rd International Conference on Transportation Geotechnics (ICTG 2016)

A New Granulation Method with the Process of Crumbling Partially-Cemented Liquid Muds and its Application to a Motocross Track

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Abstract
A new method for granulating liquid muds was proposed. This method involves the crumbling of partially cemented muds. The crumbling is the re-stirring of the cement–mud mixture when certain time elapsed after the cement was added to the liquid muds. Laboratory experiments revealed that the cone indices of the cement-mud mixtures measured after they are primary cured can be used to control the possibility of granulation and the particle size of granules obtained. The test results also indicate that the granules show high potential for use in materials such as reclamation, subgrade or backfill materials. The application of this crumbling granulation method in the maintenance work of a motocross track was also presented in this study.

Keywords: Liquid mud, Cement-treated soil, Granulation, Cone index, Motocross track

1 Introduction

Most of liquid muds derived from dredged soils and construction sludge have been disposed as industrial wastes or construction surplus soils. Therefore, techniques to granulate and solidify such liquid muds to effectively use them as land reclamation, back-filling, roadbed materials etc. have been proposed and are put into practical application.

To granulate and solidify the liquid muds, a polymer in addition to cement is generally added to the muds as a flocculation agent. However, this conventional granulation and solidification method of adding a polymer as a flocculation agent is in general a costly processing method.

In view of above, the granulation method with the process of crumbling partially-cemented liquid muds is proposed in this paper to solve such issues. This technology specifically adds and mixes

Selection and peer-review under responsibility of the Scientific Programme Committee of ICTG 2016

doi:10.1016/j.proeng.2016.06.013

cement into liquid muds, cures and then crumbles (re-stirs) the mixture when the liquid state transforms to plastic state or to the semi-solid state. Finally it produces granules by crumbling the processed cement-mud mixture. The appropriate timing of crumbling is further controlled simply by cone index tests.

2 Crumbling Granulation

It is known that granulation is possible when the water content of the mud is close to the plastic limit. Based on the fact, granulation of liquid muds which water contents are higher than the liquid limits, require a drying process such as sun-drying to reduce the water content of the muds. It results in a long term process. To speed up the process, an auxiliary material such as a polymer is added as a flocculation agent. The water content of the liquid muds apparently decreases after adding the polymer and quick granulation becomes possible. Adopting this method, however, as mentioned before, often leads to increase of material costs.

Granulation of liquid muds with the process of crumbling utilizes the change in consistency characteristics of the partially-cemented liquid muds as the results of the hydration reaction of the cement over time. No matter how much soils in the liquid form are stirred, granules are not formed. However, the liquid mud mixed with cement becomes from the liquid to plastic state, then to semi-solid state after from a few hours to approximately one day curing. When the mixture becomes plastic or semi-solid, the consistency characteristics change narrowing the gap between the mixture's water content and the plastic limit. Taking advantage of this change, crumbling, that is re-stirring of this processed cement–mud mixture produces granules as shown in Photo 1.

Photo 1: Granules produced by crumbling granulation

Figure 1 shows the particle size distribution of granules obtained by the crumbling granulation of the mixture of Singapore Marine Clay (SMC) and the ordinary Portland cement. The initial water content of SMC was 1.25 times of the liquid limit (80.1%) and the cement was added to the clay at a rate of A_c=10% of the clay weight. After cured for 4, 8 or 16 hours, the mixture were crumbled to obtain granules. It is also seen in the figure that the different particle size of granules could be obtained depending on the test conditions.

Producing the granules as shown in Photo 1 requires an appropriate timing control for crumbling. If the processed cement-mud mixture having an inappropriate property is crumbled, the end products would be lumpy clay or crushed solidified-lumps as shown in Photo 2. However the processed cement-mud mixture having appropriate property can produce good granules as shown in Photo 1. In the crumbling granulation method developed in this study, the appropriate timing for crumbling is simply determined by the cone index of the mixture, which can be obtained by "the test method for cone index of compacted soils" based on Japanese Geotechnical Society, 2009.