

The Field Experimental Study on Improvement of Soft Marine Clay by EK-Cementation Technique

Soo-Sam Kim

Department of Civil & Environmental Engineering, Hanyang University, Ansan, Kyeonggi, Korea

Jong-Yun Kim

Department of Civil & Environmental Engineering, Hanyang University, Ansan, Kyeonggi, Korea

Byung-Yoon Kang

Structure & Geotechnical Research Team, Rural Research Institute, Ansan, Kyeonggi, Korea

Kyung-Hwan Koh

Samsung Engineering & Construction, Seongnam, Korea

ABSTRACT

This study presented the results of pilot test to evaluate the applicability of EK-cementation method in field. EK-cementation method is a new method to inject specific cementation material or decompose corrosive electrode using electrokinetic (EK) phenomenon. To evaluate the effective applicability in field, various influential factors identified in laboratory test for the EK-cementation method were reflected into the field design and the following 3 conditions were employed; electric decomposition in electrode, EK-injection and the complex method which uses both electric decomposition and EK-injection. During the pilot test in field, the cone penetration test was performed in order to evaluate the ratio of strength increase for the improved In-situ ground. The ground which has similar conditions with the one where cone penetration test was performed was selected for sampling and it was used for triaxial test, consolidation test and geoenvironmental test to analyze the origins of the shear strength increase.

KEY WORDS: EK-cementation; applicability in field; electric decomposition in electrode; EK-injection; complex method

INTRODUCTION

Existing grouting method is a traditional injection method. It injects cementation material into pore intentionally and transfers pore water into injection material. The cementation material which was injected into pore got cemented and absorbed soil particle, and thus it increased the cohesion of soil and changed it to be impermeable (Youngho Gong, 1997). During the actual injection process, fracture injection instead of permeable injection occurs and the injection material is injected inconsistently either in vein shape or in disc shape. The hydraulic fracturing effect (cracking the ground by water pressure) caused by fracture injection leads the disturbance of ground inevitably. Although high pressure jet is used, there is a limit to apply grouting method because the injection limit of cementation material acts very sensitive towards the content of fine-grained soil. According to Karol (1990), in the case of grouting method by jet grouting, an injection was hard to perform when Silt ratio, #200 sieve percentage passing, was over 20 %

and it got harder when over 30%. Further, it was impossible to perform an injection when the coefficient of permeability of ground, $K(\text{cm/sec}) < 10^{-5}$.

In 20th centuries, many researches are conducted using electrokinetic (EK) method which is widely used in geotechnical engineering and geoenvironmental engineering areas to overcome the problems and the application limits of existing injection grouting method.

Examples are found as follows; Esrig & Gemeinhardt(1967) applied electrokinetic (EK) after injecting Calcium ion to stabilize Illitic clay. Gray & Schlocker(1967) and Sower(1970) electrified by installing aluminum electrode or by injecting aluminum sulfate to improve soft ground. Madshus & Janbu(1984) performed EK stabilization process by adding calcium chloride at anode on quick clay and Mitchell(1987) injected silicate as an injection material to increase the stability of electrokinetic(EK)slope. Ozkan et al.(1999) applied EK-injection method which injected aluminum and phosphoric acid at both anode and cathode. In 2000's, most studies were conducted to increase the degree of improvement on soft clay soil. These studies reported that EK-injection method using phosphoric acid and colloidal Silica or using Silicate cementation material, and electrolysis by iron electrode increased the shear strength much (Alshawabkeh & Sheahan, 2002; THEvanayagam & Jia, 2003; Micic et al, 2003).

However, these studies are based on laboratory test in most cases and they focus to evaluate the applicability of electrokinetic improvement technique along with the types of cementation materials used. The purpose of this study is to evaluate the influential factors of EK-cementation technique through the various laboratory tests and pilot tests executed up to now and to promote the applicability of this method in field (Kinyun Kim, 2005; Soosam Kim, 2006; Jongyun Kim, 2005; Sangjae Han, 2006).

THEORETICAL BACKGROUND

EK-cementation method is a method to inject specific cementation material into ground to improve the characteristic of the ground for the specific purpose. After installing an electrode in the ground, and applying D.C. electric field, and it transfers the cementation material fluently without the disturbance of ground by using electrokinetic (EK)