ABSTRACT

A new nondestructive test is developed for evaluating mechanical property of improved soil as well as sand and cohesive soil. Focus on the subgrade reaction differences between sandy soil and cohesive soil, a stress distribution ratio between inside and outside parts on rigid loading plate is measured by the new test device. Used samples are Toyoura sand, decomposed granite soil, kaolin, Ariake clay and cement-improved soils, which are typical sandy soils and cohesive soils. The purpose of this study is to develop a new device for measuring contact pressure distribution of geomaterials and estimate internal friction angle by correlation with the result of the triaxial compression test. It is also expected that this method is applied to the quality control in the surface layer ground. According to the loading test, the coefficient of subgrade reaction ratio between inside plate and outside plate is defined in terms of the relationship between settlement and average load intensity. As a relationship among the distributions of subgrade reaction with $\phi$ obtained from the triaxial compression test is discussed.

KEY WORDS:  Nondestructive device; subgrade; internal friction angle, contact pressure, cement-improved soil.

INTRODUCTION

Strength constants ($c$: cohesion, $\phi$: internal friction angle) are usually obtained from triaxial compression tests, and these are the most important soil parameters in a design of the soil structure. There are many kinds of destructive tests for obtaining the strength parameters of soils in direct or simple testing method. For example, in a cone penetration test, soil classification and mechanical property of the soil can be investigated easily. On the other hand, there are various artificial geomaterials such as cement-improved soil or light-weight geomaterial.

Several nondestructive tests have been proposed recently, these are used in the quality control of the improvement ground, or other geomaterials.

In order to evaluate the strength of new geomaterials, it is important to understand the difference between sandy soil and cohesive soil. In addition, when soil structures are designed, the ground is distinguished to cohesive material or frictional material. In particular, the improvement ground is designed using cohesion $c = q_u/2$ obtained by unconfined compressive strength, $q_u$. However, it is considered that the improved ground is under unsaturated condition, and internal friction angle actually exists. It becomes understimation of the strength and uneconomical. If internal friction angle $\phi$ can predict simply, it is applicable to inspect strength property and a quality control on the surface.

The purpose of this paper is to estimate internal friction angle of geomaterial using a new device for measuring contact pressure distribution. The coefficient of subgrade reaction ratio, $R$, is determined by the displacement-load intensity relationship obtained from a result of the loading test using the device. Furthermore, the internal friction angle is predicted from the experimental correlation with the triaxial compression test results.

THE OUTLINE OF DEVICE FOR MEASURING CONTACT PRESSURE DISTRIBUTION

Stress Distribution in Elastic Range

When external force is applied to the ground surface, internal stress occurs in the ground.

For the rigid foundation with frictionless surface on a semi-infinite elastic body, the contact pressure distribution is calculated based on the Boussinesq’s theory and the stress concentrates at an edge of the foundation (Matsuoka, 1999). Then the contact pressure distribution, $p$, of circular foundation is represented in Eq.1 and shown in Figure. 1(a),

$$p(r) = \frac{Q}{2\pi R^2} \cdot \frac{1}{\sqrt{1-(r/L)^2}}$$

(1)

where $Q$ is the load which acts on the circular foundation, $L$ is the radius of the loading plate, and $r$ is the radius from a center of the plate. However, the contact pressure on a sandy soil ground concentrates at a central part of the foundation as shown in Fig. 1(b), because near the