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Estimation of Skin Friction of Pile Shaft in Remolded Clay

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ABSTRACT

Testing results obtained from simple shear and direct shear tests conducted for investigating the frictional properties between steel pile shaft and silty clay are reported in this paper. Based on the analysis of results of these tests, a hyperbolic curve fitting method for estimating skin friction of pile shaft is proposed. The proposed method was verified by checking the computed and observed results of undrained uplift of model piles.

INTRODUCTION

In a marine environment, pile foundations are used extensively to support many of the platform structures. In this condition, pile shaft supports most of the uplift load. Two methods can be used to estimate the frictional strength of a pile shaft. One is the empirical method, but the frictional resistance estimated is usually more conservative than that occurring in actual conditions. The other one is the loading test method, which estimates the bearing capacity of pile accurately according to the actual testing data. However, this method needs a lot of labor and materials that invariably increase the engineering cost.

Tominaga and Hanzawa (1986) predicted the frictional strength of piles in the field by applying the results of laboratory direct shear tests, and the predicted value was verified by field measurements. Tominaga and Hanzawa discovered that the frictional strength estimated by the coefficient of friction obtained from direct shear tests, in-situ effective overburden pressure, and roughness of pile surface, is pretty close to the measured values. To compare empirical formulas and field measurements, Tominaga and Hanzawa found that the empirical formulas offered a conservative result. Although Tominaga and Hanzawa applied direct shear tests to get well-predicted values, Randolph and Wroth (1981) proposed that when a pile supports an external force, the deformation behavior of soil elements surrounding the pile appears to be similar to a simple shear condition.

Brumund and Leonards (1987), Chang et al. (1990), Kishida and Uesugi (1987), Mochtar and Edil (1988) and Potyondy (1961) discovered that a relationship exists between frictional resistance of the pile-soil system and the surface roughness of pile materials. Some design manuals have also given various suggestions on friction resistance angles between pile materials and soils (Winterkorn and Fang, 1976; Hunt, 1986). In this paper we consider the influences of surface roughness of piles on their frictional properties, and investigated the frictional strength between cohesive soil and pile material during the loading period.

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KEY WORDS: Skin friction, friction ratio, steel pile, sliding displacement, remolded clay.

SOIL SAMPLE AND TEST EQUIPMENT

Soil Sample

Soil samples used in this research were obtained from the Taipei Basin. The physical properties of the soil are shown in Table 1.

Specific gravity, G_s	2.68
Liquid limit, LL (%)	34.7
Plastic index, PI	15.8
Natural water content (%)	34-35
Unified soil classification	CL

Table 1 Physical properties of soil sample

Direct and Simple Shear Tests

Direct and simple shear tests were conducted in this research. The soil sample was trimmed into a cylindrical shape 6.2 cm in diameter and 1 cm thick, and placed on a steel plate. The simple shear apparatus is almost the same as the direct shear apparatus, but a set of rings coated with teflon were used instead of the upper half of the shearbox. A 2.5-cm thick steel plate, which represents pile materials, was used instead of the lower half of the shearbox. The surface roughness of the steel plate was changed by trimming the surface of the steel material with sand papers or file. The SURFCOM 110B surface texture measuring instrument was used to measure the surface roughness of the steel material. R_{max} was used as a factor to express the quantity of surface roughness (JIS, 1982). Fig. 1a shows the method to evaluate the roughness by

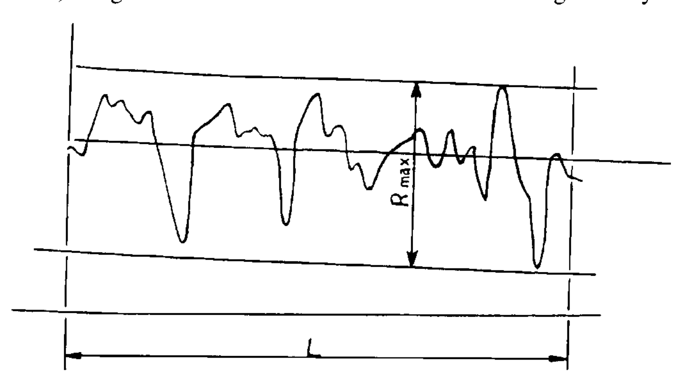

Fig. 1a Definition of roughness R_{max} (JIS, 1982)