A Study on the Undrained Characteristics of Highly plastic soils II: Factors on Strength

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Abstract The investigation of the undrained strength and the important several undrained geotechnical properties was, in detail, made for highly plastic soils using the field and laboratory testing results. The plastic index, activity, water content, and effective unit weight did not show the notable relationship with both Su and normalized Su. The OCR, sensitivity, and undrained elastic modulus presented remarkable tendency with normalized Su. It could be concluded that the use of the normalized Su may lead to the reasonable results then the normalized Su needs further research.

Key Words : Normalized strength, Highly plastic, Undrained strength, Property

1. Introduction

The undrained geotechnical properties are so important that the overall safety of ground and structures might depend on their values specially under undrained condition such as the short-term stability checking for clayey soils[1-4].

In this study, the investigation of the undrained strength and other properties is continued as the second part in the series study on the undrained characteristics for highly plastic soils[5,6].

2. Discussions of undrained strength

Fig. 1 to 8 show the relationships between the major geotechnical properties and the undrained strengths, which were obtained from the unconfined(Un), the unconsolidated and undrained triaxial(UU), and the field vane(FV) testings conducted for the highly plastic soils in Gadeokdo, Busan. The water content, OCR, plastic index, activity, void ratio, sensitivity, effective unit weight, and undrained elastic modulus are used as the major properties and the other properties were excluded since they did not show any reasonable results. The other geotechnical profiles and characteristics of the soils including the...
undrained strengths with depth are described in Kim(2012)[6].

The water content does not present any remarkable trend with the undrained strengths in Fig. 1 but shows a tendency with the normalized strengths, specially, slightly inverse proportion to the normalized Su(UU) and Su(FV). In Fig. 2, the effective unit weight has no notable tendency to both Su and normalized Su. This is unexpected because the water content and effective unit weight have been thought to have the obvious trend with Su.

![Fig. 1](image1.png)

(a) Water content and Su
(b) Water content and normalized Su(Un)
(c) Water content and normalized Su(UU)
(d) Water content and normalized Su(FV)

![Fig. 2](image2.png)

(a) Effective unit weight and normal. Su
(b) Effective unit weight and normal. Su(Un)
(c) Effective unit weight and normal. Su(UU)
A Study on the Undrained Characteristics of Highly plastic soils II: Factors on Strength

The OCR has no relation to Su as shown in Fig. 3 (a); however, the notable and unexpected tendency, which is direct proportional to the normalized Su, is observed in Fig. 1 (b) to (d).

The PI has no effect on Su in Fig. 4 (a), on the other hand, it is likely to have inverse proportion relation to the normalized Su, especially Su(UU) in Fig. 4 (c).

The Activity gives, as expected, similar trend as PI(Fig. 5) since Ac is direct proportional to PI for the soils used in this study[6].

![Fig. 2] Effective unit weight and normal. Su(FV)

![Fig. 3] OCR and normalized Su

![Fig. 4] OCR and normalized Su(FV)

![Fig. 5] PI and normalized Su(UU)
It could be found that both Su and normalized Su increase with the decrease in the void ratio in Fig. 6. This might be natural because large void ratio implies the soft state leading to low strength.

The sensitivity presents, as shown in Fig. 7, the significant result that it has the direct proportional to the normalized Su. This could be a new area requiring future research since the sensitivity has not yet been successfully related to Su.
A Study on the Undrained Characteristics of Highly Plastic Soils II: Factors on Strength

(b) Void ratio and normalized $Su(\text{Un})$

(c) Void ratio and normalized $Su(\text{UU})$

(d) Void ratio and normalized $Su(\text{FV})$

[Fig. 6] Void ratio and normalized $Su$

(b) Sensitivity and normalized $Su(\text{Un})$

(c) Sensitivity and normalized $Su(\text{UU})$

(d) Sensitivity and normalized $Su(\text{FV})$

[Fig. 7] Sensitivity and normalized $Su$

The undrained elastic modulus $E_u$ clearly increase with the increase of $Su$ in Fig. 8.

(a) Sensitivity and $Su$

(a) Undrained modulus and $Su$
5. Conclusions

The water content, effective unit weight, PI, and activity have, unexpectedly, no remarkable trend with Su for the highly plastic soils. On the contrary, OCR, sensitivity, and undrained elastic modulus showed clear tendency with normalized Su. It might be thought that the deduction of the empirical relations between normalized Su and various properties could be possible.

References


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<Research Interests>
Geotechnical Engineering, Soils and Foundations, Ground Exploration and Testing, Constitutive Relations, Numerical Analysis, Underground