Difference in components of shear resistance for samples from two earth-fill remains

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1. Introduction

According to the archaeological arguments, both of Yoshinogari Fun-kyu tomb in Japan and Jiangnan Tu-dun tomb in China were constructed by the means of compaction about two thousands years ago[1)]. From the viewpoint of geotechnical engineering, these two earth-fill tombs have experienced about two thousands years aging, it means that mechanical properties of structured soils, structure derived from methods of construction, used for construction of these earth-fill tombs changed after two thousands years. This research shows the difference in the change of mechanical properties of soils sampled from two earth-remains resulted from two thousands years aging, then attempts to explain the reasons for the difference.

2. Properties of soils sampled from two earth-fill remains

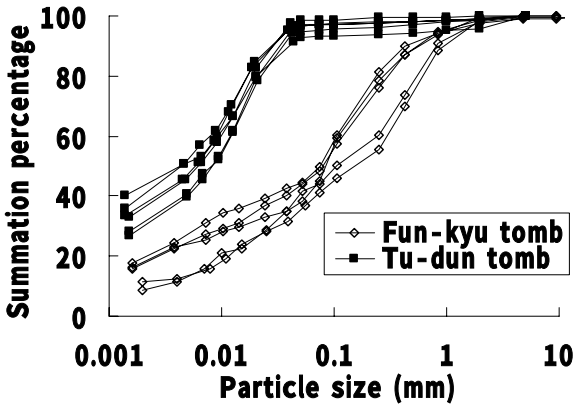

Figure 1. Particles size distribution for soils from two remains

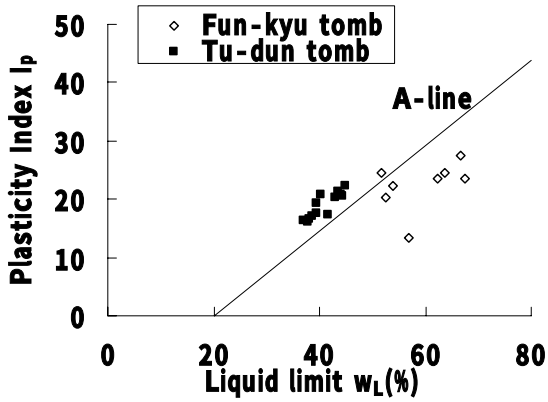

Figure 2 Atterberg limits for soils from two remains

Figure 1 is the particles size distribution for soils from two remains. Soil sampled from Yoshinogari Fun-kyu tomb has relatively larger sand and silt fractions than that from Tu-dun tomb. The Atterberg limits for these two kinds of soils are plotted in the Figure 2. As shown in Figure 1 and 2, soil sampled from Yoshinogari and Tu-dun tombs can be generally categorized as MH and CL respectively.

3. Characteristics of shearing

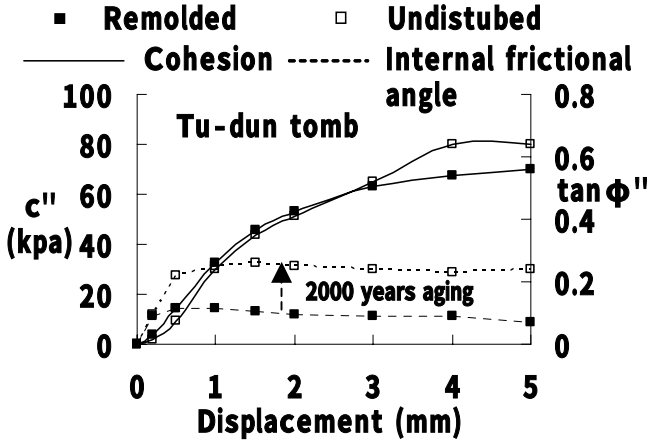

Figure 3 c" and Φ" separation for Tu-dun tomb

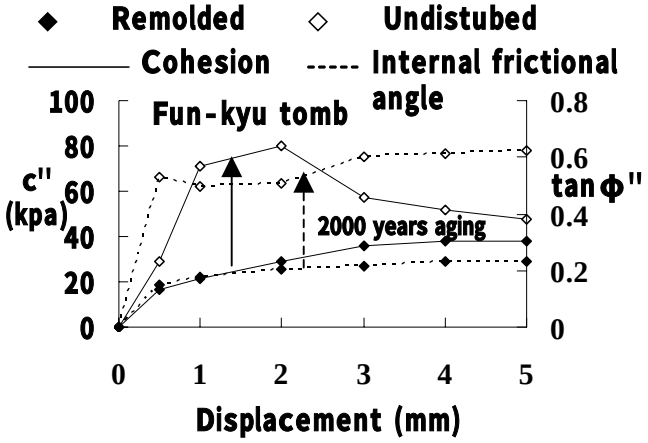

Figure 4 c" and Φ" separation for Yoshinogari Fun-kyu tomb

In this research, the difference between mechanical properties of undisturbed and remolded samples is regarded to result from influence of two thousands years aging on properties of samples. Considering particles interaction transmitted within short-range in structured soils, variation in shearing characteristics resulted from change in soils structures or occurrence of cementation should be related to displacement, therefore, in this research displacement-dependent cohesion c" and internal frictional angle Φ" were separated. The typical characteristics of shearing in samples from two remains are shown in Figure 3 and 4. After two thousands years aging, in small value of

displacement (<3mm) results of samples from Yoshinogari Fun-kyu tomb show an increase in both of cohesion and internal frictional angle, whereas results of samples from Tu-dun tomb indicate that comparing with cohesion, internal frictional angle increases due to two thousands aging but cohesion in undisturbed samples is similar to that in remolded samples.

4. Analysis of difference in characteristics of shearing for samples from two earth-fill remains

Mechanical properties of soil change in two thousands years since completion of remains are primarily related to its mineralogical composition. Comparing with sand and silt fractions, clay fraction exhibits stronger ability to adhere with water which is closely related to readjustment of soil structure. Figure 5 shows values of activity[2] for two patterns of soils. As shown in Figure 1, although the clay fraction in soils sampled from Tu-dun tomb is larger than that in soils sampled from Yoshinogari Fun-kyu tomb, the corresponding plasticity index is relatively lower, for convenience, the value of activity is calculated on clay fraction smaller than 5μm. Correlation the value of activity with corresponding variation of cohesion and internal frictional angle in samples is shown in Figure 6. The general tendency of change in cohesion is that the higher the value of activity, the more increase in cohesion, on the contrary, variation in internal frictional angle shows the opposite tendency.

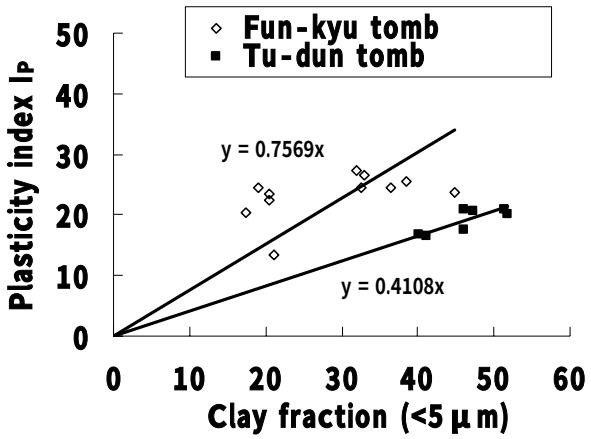

Figure 5. Values of activity for soils from two remains

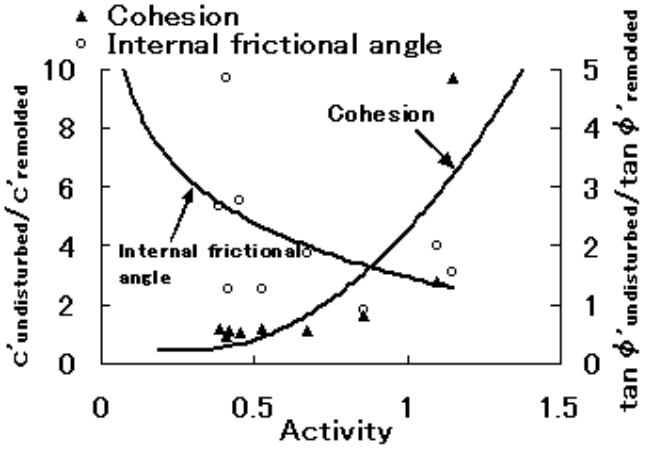

Figure 6. Activity corresponding with variations of shear components

On the other hand, results of chemical composition analysis [1] indicate that soils sampled from Yoshinogari Fun-kyu tomb is composed of volcanic ash Aso-4, classified as Pozzolanas which in itself possess little or no cementitionous trait but will, in the presence of moisture, chemically react with calcium hydroxide at ordinary temperature to form compounds possessing cementitous properties[3]. The constituents of soils sampled from Tu-dun tomb are weathered soils, and Quartz (SiO_2) is primarily clay mineral resulting in inactive properties of soils sampled from Tu-dun tomb. The difference between Figure 3 and 4 can be attributed to occurrence of cemented bonds due to pozzolantic reaction in Yoshinogari Funkyu-tomb.

5. Conclusions

According to the analysis of physical properties and chemical components of soils sampled from two earth-fill remains, several conclusions can be drawn as following:

1. Comparing with soils from Yoshinogari Fun-kyu tomb, soils sampled from Tu-dun exhibits larger clay fraction but lower value of activity.
2. After about two thousands years aging, the increase (Fig.4) in c'' for soil sampled from Yoshinogari Fun-kyu tomb is contributed to the chemical components classified as Pozzolans resulting in occurrence of cemented bonds between soils particles.
3. The variation of cohesion and internal frictional angle with corresponding value of activity shows that the higher the value of activity, the more increase in cohesion, on the contrary, internal frictional angle possesses opposite tendency as value of activity increases after two thousands years aging.

Reference

1) Onitsuka.K et al. 2003. Geotechnical characteristics and construction methods of Yoshinogari Fun-kyu tomb in Japan and Tu-dun tombs in China, Journal of JSCE, III-63, No.736. 2). Skempton. A.W. 1953. The colloidal 'activity' of clays, Pro. 3rd Int. Conf. Soil Mech., Zurich, Vol.1 pp.51-61. 3). Sherwood, P. T. 19993. Soil stabilization with cement and lime, HMSO publication.