Definition of Collapsibility Property to Shirasu Soil

KyushuUniv. ○ S.Mem. D. HORMDEE ; F.Mem. H. OCHIAI
KyushuUniv. Mem. N. YASUFUKU ; Mem. S. YAMADA

Introduction

According to the study on the collapsibility property of soil, it is necessary to realize the suitable material used for further purposes. As the knowledge of collapsible soil, it is one in which the constituent parts have an open packing and which forms a metastable state that can collapse to form a closer packed, more stable structure of significantly reduced volume. A method of including the basic soil types in a single figure is to use a flow chart, or tree, of collapsible soils, such as that shown in Figure 1. The subject of collapsible soils has been, perhaps necessarily, approached from individual disciplines and from country, or continent, specific deposits. One of the most popular methods to identify the collapsible soil is the double consolidation test

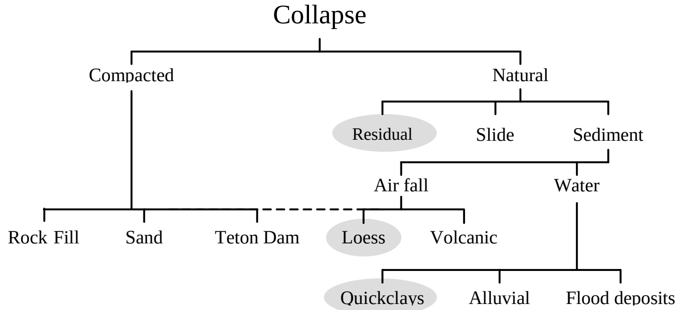


Figure 1: A classification of collapsible soil (Rogers, 1995)

Table 1: Index properties of Shirasu soil

Property	Shirasu
Specific gravity	2.54
Water content (%)	0.6-1.3
Soil classification (JIS)	SM
Optimum moisture content (%)	8.1
Maximum dry density (g/cm^3)	1.44
γ_{dnin} (g/ cm^3)	0.954
γ_{dnax} (g/ cm^3)	1.297

Methodology

The sample used in this research is “Shirasu”, volcanic sandy soil. Table 1 shows the summary of Shirasu soil properties for disturbed sample, less than 0.85 mm particle size, with air dry water content. To prepare the sample for consolidation test, it needs to be compacted by the small hammer getting the dry density in the range of 1.18 to 1.36 g/ cm^3.

The applied load in consolidation test uses air pressure to modified oedometer apparatus, maximum load of 1000 kPa for both soaking and unsoaking cases - normal air dry water and the one with added 15% of water. The soaking pressure was performed in many states as shown in Table 2.

Table 2: Summary the type of testing

Test	Test A	Test B	Test C	Test D	Test E
	15% water content	air dry with unsoaking	air dry soaking at 160 kPa	air dry soaking at 320 kPa	air dry soaking at 20 kPa
w_0	15.0%	1.32%	1.32%	0.65%	0.65%
γ_{d0} (g/cm^3)	1.18	1.36	1.28	1.31	1.33
e_0	1.14	0.87	0.98	0.94	0.92
Dr	73.7%	112.2%	96.9%	102.5%	106.0%
S	32.5%	3.85%	3.43%	1.77%	1.82%

Results and Discussion

From Figures. 2 and 3, this Shirasu soil can be classified as silty SAND (SM) from the Japanese standard with optimum moisture content and maximum dry density are 8.1% and 1.44 g/cm^3, respectively.

Figure 4 shows the results of double consolidation test with five different types of test that summarized in Table 2.

Figure 2: Compaction Curve

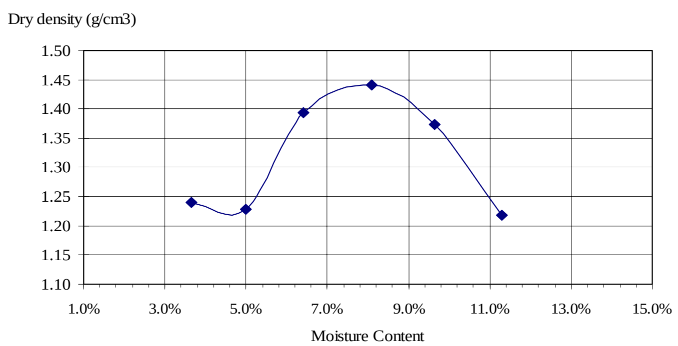
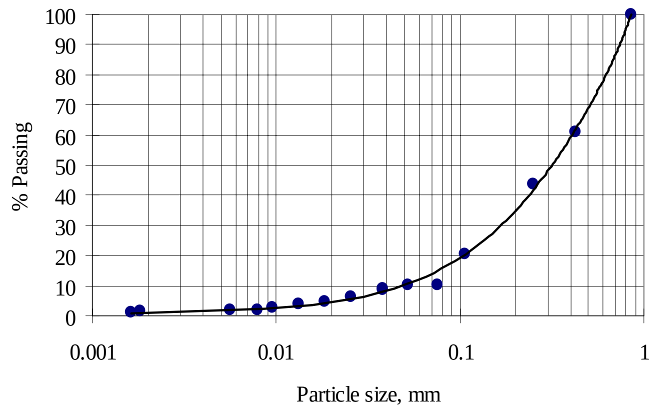


Figure 3: Grain size distribution curve



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Department of Civil Engineering (Suiko), Kyushu University, Hakozaki, Higashi-ku, Fukuoka 812-8581 Tel: 092-642-3286

There are two main cases of test as unsoaking (Test A and B) and soaking with water (Test C to Test E). In the case of unsoaking sample, Test A, additionally initial water content to 15 %, gain more settlement than the case of air dry water content, Test B. One reason should be from the amount of water among the soil particles-the more amounts, the more lubricated and easier to rearrange to the next stable state. And mixing the water up to wet side of compaction curve, as 15%, achieves more compression than dry side of compaction curve, as Test B.

In case of soaking samples, Test C and Test D compare to Test B. Before soaking, they have the same trend with air dry water content case in Test B. Then after soaking, they seem to change to be the same trend of Test E, soaking at 20 kPa, as the result of the same condition after soaking, as saturated soil.

Considering in Test E, swelling occurs when soaking with water because of not enough in surrounding pressure comparing to the maximum past pressure. As shown in Fig. 4, the swelling trends to decrease with increasing pressure to soaking, contrast to the magnitude of collapsibility that increases with increasing in pressure. Then it can be implied that one of the influences on the value of both swelling and collapsing phenomena depends on the degree of overconsolidation ratio in that pressure.

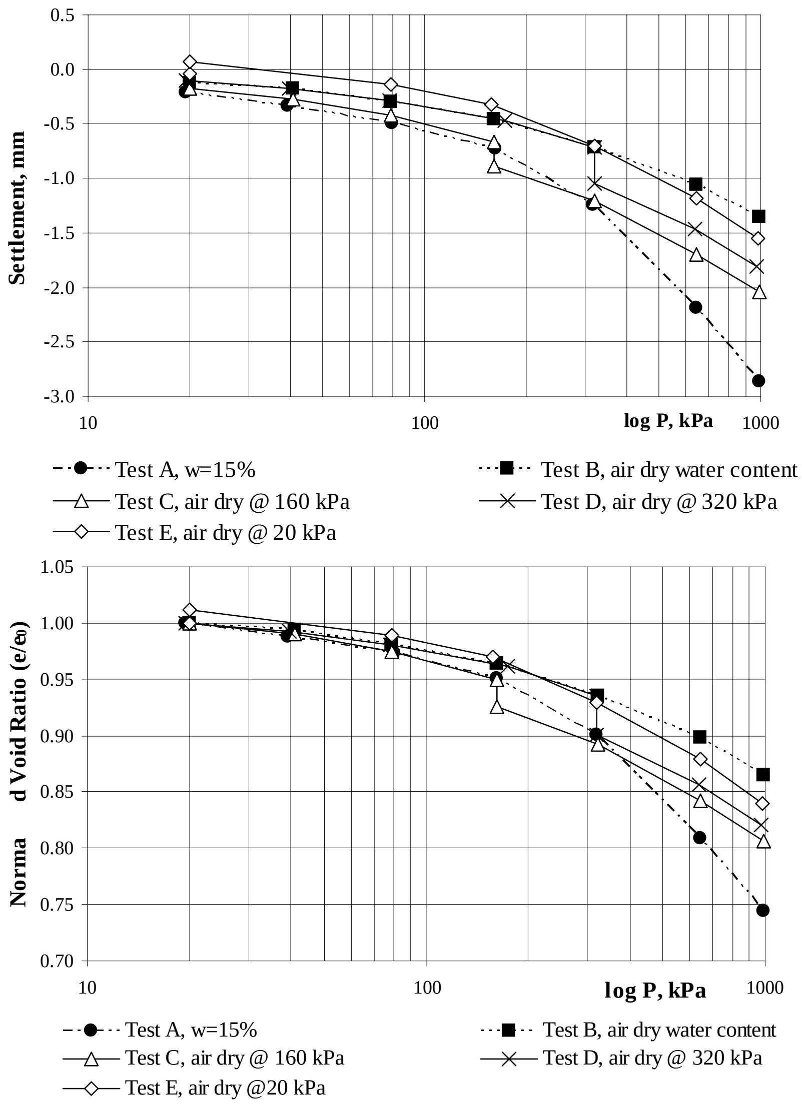

Figure 4: Consolidation Curve

Conclusions and Recommendation

1. When Shirasu soaking with water, it gains more settlement without increasing the vertical pressure except when soaking at small pressure, the swelling is occurred. And the more applied pressure for soaking, the more compression magnitude.
2. After soaking point, the consolidation curves trend to be parallel, little bit steeper slope than normal initial dry in settlement-log P curve.
3. Initially addition water content before performs the consolidation test get the largest settlement among other tests.

Further study

1. Soaking with water at different initial water content condition.
2. Soaking with other liquids for studying the properties changing of collapsible soil.
3. Finding the methods to improve the high compression in collapsible soil when soaking.

Reference

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