The 2017 World Congress on
Advances in Structural Engineering and Mechanics (ASEM17)
28 August - 1 September, 2017, Ilsan(Seoul), Korea

A Study of Loading Time Effect in Oedometer Test

*Sanchari Halder[1], Ji-Seung Park[2] and Myoung-Soo Won[3]

[1), 2), 3)] *Department of Civil Engineering, Kunsan National University, Gunsan, South Korea*
[1)] *sanchari.halder@yahoo.com*, [2)]*Wehappy7@nate.com*, *and* [3)] *wondain@kunsan.ac.kr*

ABSTRACT

In this study, the effect of loading time on clayey soil has been investigated through oedometer test considering double and single drainage. The test has been conducted for six times with loading time span of 12, 24 and 72 hours. Application of consolidation loads has been varied from 9.8 kPa to 628 kPa with increment ratio of 1:2. The effect of the loading time for 12, 24 and 72 hours on the e-log p curves was negligible for both single drainage and double drainage. The e-log p behaviours of double drainage and single drainage were similar. However, the void ratio in the case of double drainage was little smaller than single drainage because the instant settlement for double drainage was larger than single drainage. Although, consolidation co-efficient C_v and secondary compression index C_α both exhibited the considerable effect of different loading time span due to clayey soil's time dependent characteristics.

1. INTRODUCTION

Soil structure is made of basic elements called grains. When subjected to mechanical loading, rearrangement of the grain structure occurs which creates irreversible volumetric strain (Hattab and Hicher 1995). Laboratory tests and field observations reported by (Taylor 1942) clearly indicated the effect of time on the compressibility of clays. The oedometer test simulations indicate good agreement with stress-strain and strain-log time test results during loading (Perrone 1998). Few researchers have addressed the effect of different loading time on clayey soil structure. This paper is an overview of a preliminary attempt to analyse the effect of varying loading time through oedometer tests.

---

[1] Graduate Student
[2] Graduate Student
[3] Assistant Professor

2.1. TEST EQUIPMENT

The tests have been carried out by standard incremental loading type oedometer with computer control and logging facilities, Fig.1 and 2. The 6 cm internal diameter brass oedometer ring used in present study was fitted with loading equipment for measuring the vertical deformation of the soil sample. To avoid side friction, the cell apparatuses has been coated well with grease. The load on the specimen has been applied through a lever arm, and compression has been measured by the data logger. The specimen has been kept submerged in water during the test.

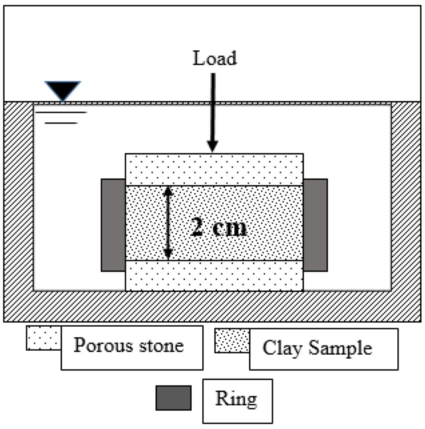

Fig.1: Schematic diagram of an oedometer, Das (2009)

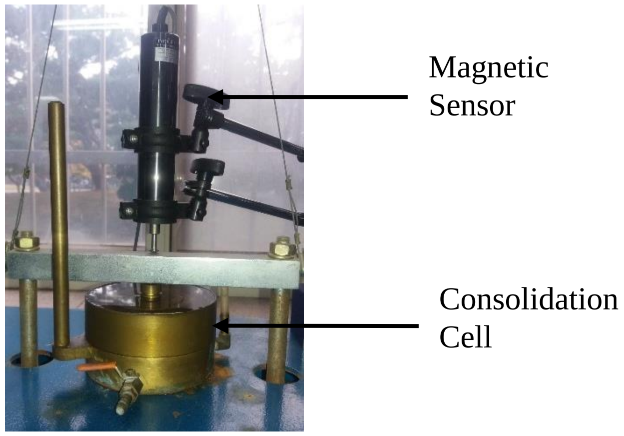

Fig. 2: Oedometer cell assembly

2.2. SOIL SAMPLE

The basic properties of the samples used in oedometer tests have been shown in Table 1. The soil has been acquired from Sayemangeum area of South Korea using 100 mm dia tube sampler. The soil has been determined as soft clay with lower sand proportion. The soil samples have been kept under water for 24 hours, before starting the oedometer tests.

Table 1: Physical Properties of soil sample.

Liquid limit, LL (%)	41
Plastic Limit (%)	24
Plasticity index, PI	17
Specific Gravity, G_s	2.67
USCS Class	CL, Clay

2.3. EXPERIMENTAL PROCEDURE

The oedometer tests have been regulated under there different kind of loading time span, 12, 24 and 72 hours. For each type of loading time span, the samples have been tested considering two types of drainage path, single and double. Therefore, six oedometer tests cases have been attained in total. Incremental loads have been applied varying from 9.8 kPa to 628 kPa with increment ratio of 1:2. Two loading-unloading-reloading cycles have been introduced to investigate consolidation behaviour. Distribution of loading pattern considering 12, 24 and 72 hours of time span has been shown in Table 2.

Table 2: Elapsed time span for each loading step of oedometer test.

Case number		Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Drainage type		Single	Double	Single	Double	Single	Double
Type of load	**Applied load (kPa)**	**Elapsed time (Hour)**					
Loading	9.8	12		24		72	
Loading	19.6	12		24		72	
Loading	39.3	12		24		72	
Unloading	19.6	4					
Unloading	9.8	4					
Reloading	19.6	4					
Reloading	39.3	4					
Loading	78.5	12		24		72	
Loading	157	12		24		72	
Unloading	78.5	4					
Unloading	39.3	4					
Reloading	78.5	4					
Reloading	157	4					
Loading	314	12		24		72	
Loading	628	12		24		72	

3.1. EXPERIMENTAL RESULTS (DEFORMATION READINGS BY DATA LOGGER)

The test data highlighted slightly additional deformation for samples with 72 hours loading time span while comparing with 12 hours and 24 hours loading time span. Samples with double drainage path exhibited greater instant settlement than single drainage samples, Fig. 4, 5 and 6.

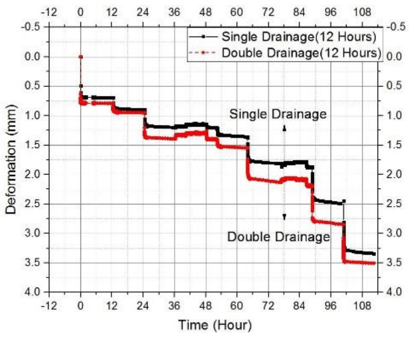

Fig. 4: Deformation for 12 hours time span.

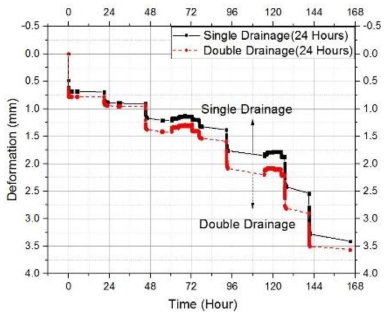

Fig. 5: Deformation for 24 hours time span.

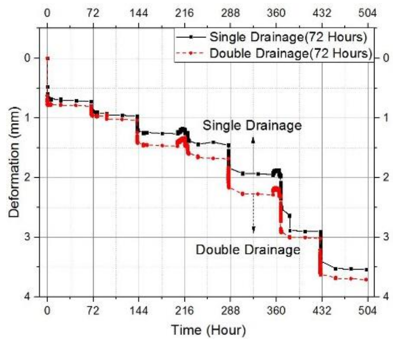

Fig. 6: Deformation for 72 hours time span.

, Fig. 7 and 8 illustrate percent cumulative deformation for increasing load and time in a three-dimensional plot. All of the six oedometer test cases showed about 19% to 20% of instant settlement for first loading step of 9.8 kPa.

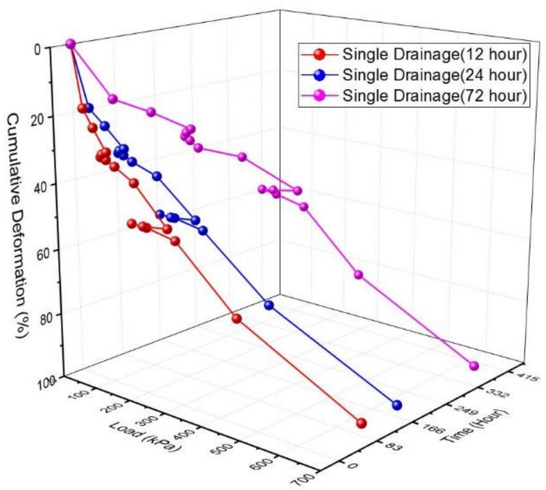

Fig. 7: Cumulative deformation (%) for single drainage.

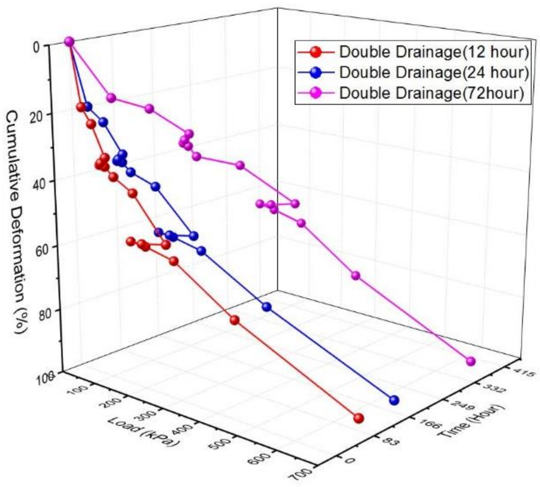

Fig. 8: Cumulative deformation (%) for double drainage.

Analysis of deformation readings demonstrated no significant influence for different loading time span of 12, 24 and 72 hours.

3.2. LOADING TIME EFFECT ON VOID RATIO, e

Samples regulated under 72 hours loading time span exhibited lower void ratio compared to 12 and 24 hours loading time, Fig. 9 and 10.

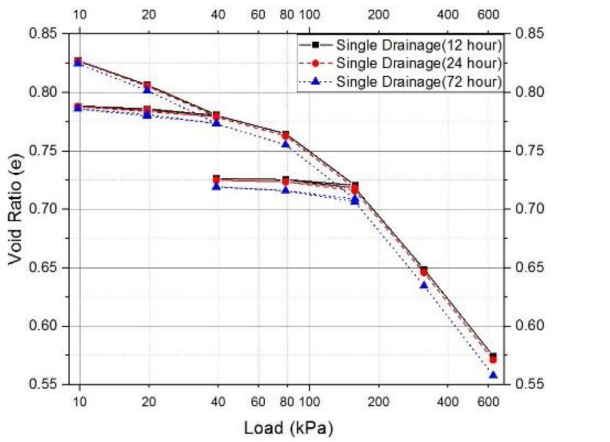

Fig. 9: Void ratio,e vs load(log) for single drainage.

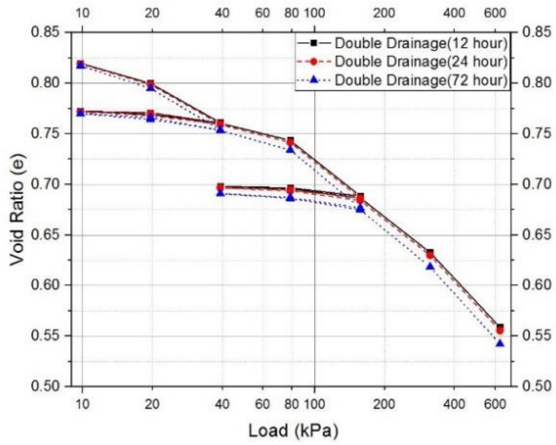

Fig. 10: Void ratio,e vs load(log) for double drainage.

3.3. LOADING TIME EFFECT ON COEFFICIENT OF CONSOLIDATION, C_v

The coefficient of consolidation, C_v values showed reducing the rate to increasing loading time span for each loading step. Samples with 72 hours loading time had the lowest amount of C_v values, Fig. 11 and 12. Single drainage samples appeared to have bigger C_v values than double drainage. Cv curves representing single and double drainage respectively display certain undulation or rise and fall trend following loading-unloading-reloading cycles executed in oedometer test.

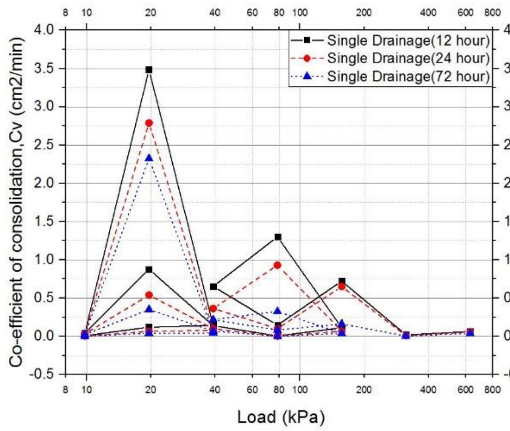

Fig. 11: C_v vs load (log) for single drainage.

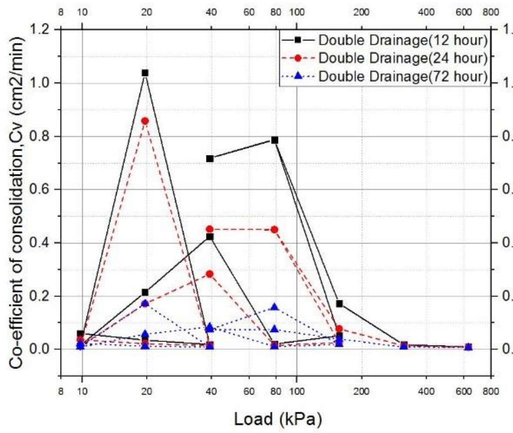

Fig. 12: C_v vs load (log) for double drainage.

3.4. LOADING TIME EFFECT ON SECONDARY COMPRESSION INDEX, C_α

The secondary compression as in long term consolidation index, C_α demonstrated similar behaviour like coefficient of consolidation, C_V. Loading time of 12 and 72 hours showed respectively highest and lowest magnitude of C_α values, Fig.13 and 14.

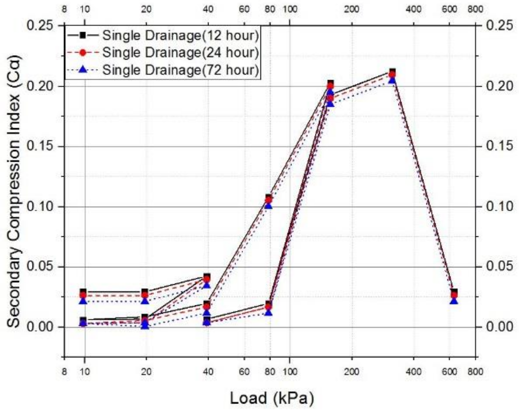

Fig. 13: C_α vs load (log) for single drainage.

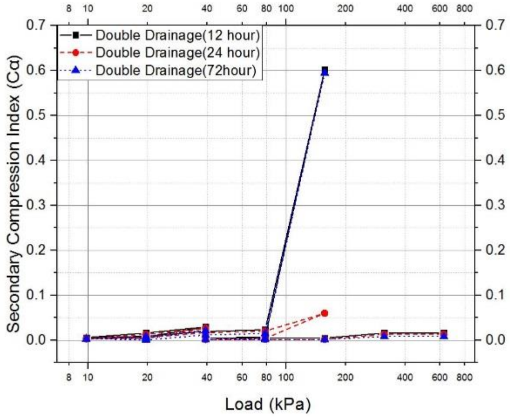

Fig. 14: C_α vs load (log) for double drainage.

4. CONCLUSION

This study was an observational attempt to focus on the consolidation behaviour of clayey soil for varying loading time. The evidence from this study point towards the idea that consolidation rates, co-efficient C_V and secondary compression index C_α get affected for increased loading time due to the time-dependent plastic adjustment of soil fabric. Nevertheless, loading time effect on void ratio was visibly insignificant for both single and double drainage. Future improved research on the current topic is required in order to validate this idea.

5. REFERENCE

Hattab, M. and Hicher, P.Y. (1995), ‘‘Experimental study of the dilatancy in overconsolidated clay.’’ Compression and Consolidation of Clayey Soils, Vol. 1,57-62.

Taylor, D.W., (1942), "Research on Consolidation of Clays," Department of Civil and Sanitary Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, Serial 82.

Perrone, V.J. (1998), "One-Dimensional Computer Analysis of Simultaneous Consolidation and Creep of Clay," Department of Civil Engineering, PhD Thesis, Virginia Polytechnic Institute and State University.

Das, B. M. (2009), “Principles of Geotechnical Engineering”, Cengage Learning, Stamford, USA, 7th Edition, pp. 294~364.