Case Studies on Calibration Chamber Test with Clay

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Abstract: Case studies reported in the literatures were reviewed and summarized to better understand the laboratory calibration chamber tests for testing in-situ test devices and model piles in clay soils. Total of 4 cases studies are presented to review the clay preparation methods, characterize the clay slurry, and identify the calibration chambers. Kaolinite clay with and without sand or silt, with undrained shear strength in the range of 16 to 80 kPa, were used in these studies.

1 Introduction

In order to develop and validate either empirical or theoretical models in geotechnical engineering, field and laboratory tests are essential. Since the field calibration tests have many limitations and disadvantages due to soil inhomogeneities and uncertainties regarding the magnitude of in situ stresses and the stress history of the deposit, laboratory calibration tests have definite advantages such as homogeneity, reproducibility, and controlled boundary conditions. Based on the literatures, laboratory calibration tests of in-situ test devices and model piles have been performed on clay soils using large calibration chambers (1-4). There are four major aspects to review the laboratory calibration chamber tests, which are designing the calibration chamber, boundary conditions, preparing large cohesive soil specimen, and instrumentation.

2 Objectives

The objective of this study was to identify the common features and differences observed in the calibration chamber testing systems for testing in-situ test devices and model piles in clay soils.

3 Calibration Chamber Testing System

Total of 4 case studies were reviewed and analyzed.

a. Specimen Prepation: Clay specimen can be prepared by clay slurry consolidation method and clay compaction method. Based on the literature, clay slurry consolidation method was preferred to simulate the stress history of the soil deposit. The clay slurry specimens were prepared in two stages: Slurry consolidation in a consoildometer from a high water content soil slurry and reconsolidation to high stresses in a calibration chamber. The clay slurries used are summarized in Table 1. Liquid limit of the soil specimens varied from 20 to 72 %. Slurry moisture content varied from 1.5 to 2.5 times the liquid limit. Undrained shear strength varied from 16 to 80 kPa.

b. Consolidometer and calibration chamber: Clay slurry was initially consolidated under K_0 conditions in a rigid wall consolidometer to form a clay specimen which was then put in large diameter triaxial cell (Calibration chamber) and reconsolidated under either an isotropic or anisotropic stress regime. However, the size of the clay bed was such that it could not be moved between K_0 consolidation and triaxial reconsolidation, so the chamber was designed to allow full preparation and testing without having to move the clay bed. The slurry consolidometers & calibration chambers used are compared in Table 2. The diameter of the test chambers and consolidometers varied from 200 to 1372 mm.

c. Boundary condition: The four boundary conditions that have been used are as follows:

BC1: Constant vertical stress (σ_v - Constant) and constant lateral stress (σ_h - Constant)

BC2: Zero vertical strain and zero lateral strain (K_0)

BC3: Constant vertical stress and zero lateral strain (K_0)

BC4: Zero vertical strain and constant lateral stress (σ_h - Constant)

d. Instrumentation: In most cases, piston displacement and pore water pressure measurements were made during slurry consolidation to determine when the consolidation process had been completed and to check the extent of pore water pressure dissipation.

5 Conclusions

Kaolinite clay with fine sand was used. Slurry method with soil moisture content above liquid limit was used to prepare the specimens. Chamber size varied from 200 mm to 1372 mm. Test conditions varied from K_0 to constant lateral stress.

6 Acknowledgement

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7 References

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Table 1 Comparison of clay slurries used in the calibration chamber test

Source	Huang et al. (1988)		Voyiadjis et al. (1993)				McManus et al. (1993)		Anderson et al. (1991)
Material	Kaolinite 50%	Silt 50%	Kaolinite 50%	Fine Sand 50%	Kaolinite 33%	Fine Sand 67%	Air-floated Kaolin 50%	Fine-ground silica 50%	Speswhite kaolin 100%
w_l *(%)*	63		30		20		33		72
w_p *(%)*	36		16		14		22		36
G_s	2.59		-		-		2.65		-
Slurry WC,(%)	2.5 w_l		2 w_l		High		2 w_l		1.5 w_l
Time, (days)	14		-		-		16.9		21~28 (+12)
1st Surcharge Stress, (kPa)	220		138		138		110 (Three layed consolidation)		280 (70 during 3 days)
2nd Back Pres., (kPa)	690 (24h)		138		138				
Max.Verti.Con. Pres., (kPa)	276				207				
Max. Eff. Verti./ Lat. Pres., (kPa)			207/207 41.4/41.4 207/107.6 (K_0=0.52)		207/207				280/280 560/560 620/405
Mean Water Content, (%)	26.5		23.32 23.97 24.11		18.56		30		45.3
Undrained Shear Strength, *(kPa)*	62 (Pressuremeter test)		60 (I_r=267) 40 (I_r=150) 65 (I_r=567)		80 (I_r=100)		16 (Vane shear) 17 (Fall cone) 21 (Pocket penetrometer)		23.8 (Lab. vane) 26.9 (Undr. Tria.)

Table 2 Comparison of slurry consolidometer and calibration chamber

Source	Huang et al. (1988)	Voyiadjis et al. (1993)		McManus et al. (1993)		Anderson et al. (1991)	
Type	One system	Consolido meter	Double-walled flexible chamber	One system Medium Chamber	One system Large Chamber	Consolidometer	Calibration Chamber
Dia., mm	200	525	525 (Inner/ Outer Shell: 560/ 580)	600	1372	785	1030
Height, mm	360 (Ini. :800)	812	815 (Inner/ Outer Shell: 910)	1200	2134	1700	1000