

# CHAPTER 1 INTRODUCTION

## 1.1 Introduction

The deposit soft clay (i.e. natural land in coastal, land of broad basin, and low land regions), general exhibits very low shear strength and very high compressibility. Due to these undesired engineering characteristics, the ground improvement technique is essential.

The ground improvement technique means modification of soil properties such as increasing soil shear strength, reducing soil compressibility and reduction of soil permeability (Bergado et al., 1996). They are mainly classified into four categories, namely: reinforcement, admixtures, compaction, and dewatering (Kamon and Bergado, 1991). The ground improvement of soft Bangkok clay being implemented in Thailand includes sand compaction piles (SCP), prefabricated vertical drains (PVD), deep mixing method (DMM), and mechanically stabilized earth (MSE). The applicability of various techniques depends on the soil types, which have been tested to provide various solutions for existing problems on soft ground that may influence their utilization. In recent years, lightweight geo-materials have been developed and widely utilized in the infrastructure rehabilitation, earth structures, and construction of new facilities, in order to reduce both overburden stress acting on an under ground structure (e.g. tunnel, buried pipe, etc.) and lateral earth pressure acting on retaining structure (e.g. quay wall, seawall, shore protection, etc.). Especially, air-cement treated soil or air-foam treated lightweight geo-material (LGM) or lightweight foam mixed soil (LFS) was appropriate to ground improvement rather than another lightweight geo-materials (e.g. add stability, less deformation, low cost, less time construction, etc) (Miki, 2002).

Many researchers (Glogowski and Kelly, 1988; Yajima et al., 1995; Naik and Singh, 1997) have made important contributions to the understanding of air-foam treated lightweight geo-material behaviours. Subsequent, the efficiency and development of air-foam treated lightweight geo-materials have been studied by means of various laboratory tests for utilization in field tests (Tsuchida et al., 2001; Porbaha and Yamane, 2004; Mori, 2005). Most of these researchers found that air-foam treated lightweight geo-material behaviour (the unconfined compressive strength and deformation) depends on both the quantity of cement and the void ratio, and can be controlled by adjusting unit weight ( $\gamma$ ), moisture content ( $w$ ), and curing time of the lightweight foam mixed soil (LFS).

## 1.2 State of the Problem

The strain levels in air-cement treated soil (ACS) at working loads in full-scale field case are usually substantially lower than the strain level at which the stress-strain curves become highly nonlinear and the significant drop of stiffness occurs, corresponding to the order of 0.1% or less. On the other hand, it is known the local axial strain measurement by means of for example, a pair of local deformation transducer (LDTs: Goto et al., 1991) in laboratory tests is imperative to evaluate reliably the stress-strain properties at such small strains of stiff geomaterials, such as stiff soils and rock (e.g. Tatsuoka et al., 1999a and 1999b). This is because the effects of bedding errors at the top and bottom ends of the specimen become significant on the axial strains calculated from the displacements of the specimen cap or the loading piston. In addition, in order to reliably evaluate lateral strains of an unsaturated specimen, it is necessary to directly

means lateral deformation of the specimen by means of, for example, clip gauges (e.g., Tatsuoka et al., 1994). Finally, even in a continuous monotonic loading (ML) compression test on geomaterials at without confining pressure, the elastic stress-strain parameters such as Young's modulus and Poisson's ratio are not constant, and are mainly affected by change in the axial stress. For this reason, these elastic parameters of geomaterials are often evaluated by intervened by sustained load (SL) and applying cyclic loading (CL) in level stress. The purpose of such tests was extended to evaluate the entire stress-strain behaviour including the peak strength (e.g., Tatsuoka et al., 1999a and 1999b). However, the systematic study on ACS based on laboratory stress-strain tests with such LDT and CGs is very limited.

In view of the above, the present study was performed aiming at evaluating the small-strain behaviour of ACS as well as the overall stress-strain behaviour based on laboratory uniaxial compression test measuring small axial and lateral strain using local gauges.

### 1.3 Objective of Study

The objectives of this study are as follows:

1. To investigate the stress – strain and stiffness of air-cement treated soil at small strain range.
2. To characterize the strength and small strain stiffness properties of air-cement treated soil with parameter so-called effective void ratio.

### 1.4 Scope and Limitation

This research has the scope as the followings:

1. The Natural Bangkok clay soil depth of 4-5 m. is remolded admixed with water, to attain the water content of 300%. The cement content,  $C$ , which is defined as 100, 150 and 200 (kg) in air foam-cement-admixed clay  $1 \text{ m}^3$ . The unit weight is desired as 8, 10 and 12 ( $\text{kN/m}^3$ ).
2. Portland cement type I is used.
3. The curing time of air-cement treated soil is investigated at 28 days.
4. Method of monotonic loading test is continuous monotonic loading (ML) with stress rate of 7.017 kPa/min.
5. Method of cyclic loading test is ML with stress rate of 7.017 kPa/min intervened by sustained creep loading 1 hour and minute cyclic of unload and reload 10 cycles.
6. Both monotonic and cyclic loading tests is for uniaxial test.