CHAPTER I

Introduction

1.1 Introduction

The occurrence of strain localization in soils is one of the significant matters in geotechnical engineering problems. This phenomenon leads to an instability within the soil mass. When the strain localization or zone of shear bands occurs, the discontinuity within soil mass will present and result in the change in the physical properties of soil, e.g. the low density of soil particles and relatively high strain within the zone of shear band. Furthermore, the load carrying capacity of soil is slightly decreased after failure because of this emergence of shear band zones. Although strain localization has been observed for a long time both by theoretical studies and laboratory experiments, it is only during the last 20 – 40 years that many scholars have conducted the in-situ and laboratory tests as well as the numerical studies to investigate strain localization in soils, especially in sand. Those studies started from the seventies by Roscoe (1970), Arthur *et al.* (1977) and Vardoulakis *et al.* (1978). These investigates had provided valuable details and innovate concepts concerning shear band characteristics in sand. Later, various theoretical, numerical and experimental studies have been continuously carried out. The results of these systematic studies reveal that the principal characteristics of strain localization, i.e. thickness and orientation of shear bands, and the strain level at which a shear band forms, depend primarily on a number of factors including the initial state of the material (mean effective stress and void ratio), grain particle characteristic (grain size, uniformity, contact surface, etc.) and size and slenderness of the specimen. Moreover, among the experimental studies of these past works, e.g. Lee (1970) and Peter *et al.* (1988), they indicated that strain localization can be visually observed through shear bands under plane strain than under conventional triaxial compression. Hence, it can also be noted that shear band formation is highly dependent on loading condition or boundary condition.

To obviously explore strain localization characteristics, additionally from plane strain and conventional triaxial test devices, complicated instrumentation techniques have been used, for example, Gamma-rays, Stereophotogrammetry, X-ray Computed Tomography, Digital Image Analysis (DIA) and Digital Image Correlation (DIC). These techniques can used to explore the strain field pattern inside the specimen during the entire test. This capacity of the modern apparatuses, as a result, can characterized the crucial features of strain localization, i.e. the pattern of shear band formation, time and evolution of strain localization.

Roesler (1979) reported that the shear wave velocity (V_s) of sand depends on the stresses in the direction of wave propagation and particle motion, and that the velocity is independent of the stress normal to the plane of shear. Many studies on shear wave velocity and determination of small strain shear modulus of soils from various researchers, e.g. Stokoe *et al.* (1995) and Bellotti *et al.* (1996), also confirm Roesler's finding. In addition to the confining stresses, the shear wave velocity also depends on the void ratio. Void ratio functions are proposed to express the effect of void ratio dependence on shear wave velocity and shear modulus (Hardin and Drnevich, 1972 and Iwasaki *et al.* (1978). Moreover, stress history, degree of saturation, grain characteristics, frequency, aging effects and soil structure also affect shear wave velocity (Richart *et al.*, 1970). A few studies in the past also indicated a sudden drop (deviation from the general accepted elastic shear modulus path) of the elastic shear modulus before and after the failure of clayey soils (Teachavorasinskun and Akkarakun, 2004 and Teachavorasinskun and Amornwithayalax, 2002). However, these phenomena, though clearly observed in the laboratory tests and theoretically confirmed by the theory of elastic wave propagation, have not been investigated in details.

As mentioned above, from the literature of strain localization and shear wave propagation in soil, we may imply that the strain localization and shear wave velocity (V_s) of soils primarily influence by the same dominant parameters; e.g. void ratio, confining pressure and grain characteristics. A brief introduction to this study is that the propagation of shear wave through the body of localized sandy sample will be adopted to characterize the mechanism of shear band formation using the laboratory tests; i.e. conventional triaxial test. The main assumptions of this method are that;

1) There must exist clear shear bands (rupture surfaces) after peak stress level and the thickness of shear bands is uniform,

2) The densities of the intact and localized zones should be distinctly different and

3) Since the velocity of shear wave is dependent on both void ratio and stress state, it is therefore necessary to carry out a detailed investigation on the stress state and void ratio dependency characteristics of shear wave velocity.

1.2 Objective of the Study

1) To observe the shear wave propagation inside the sandy soil under isotropic consolidation and triaxial compression test

2) To investigate the mechanism and the evolution of strain localization of sandy soil sample under triaxial compression test using shear wave propagation technique and Digital Image Analysis (DIA)

1.3 Scope of the Study

To clarify the problems, a literature study will be conducted including several topics. These topics consist of;

1) The ideas of strain localization and shear band of granular materials

2) The factors affecting strain localization and shear band

3) The shear wave propagation technique for geotechnical applications

4) The factors affecting shear wave propagation inside granular materials

5) The bender element testing within triaxial apparatus

After the systematic review, the experimental study to examine the correlation between shear wave velocity, void ratio and stress state of sandy soil sample by the modified triaxial apparatus will be performed. The correlation between shear wave velocity, void ratio and stress state should be established and the identification as well as the evolution of strain localization within the soil mass should also be evaluated.