



ハノイ市における繊維質材料混合流動化処理土の埋戻し地盤への適用に関する研究

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Chapter 1

Introduction

1.1 GENERAL BACKGROUND

In Hanoi and Ho Chi Minh cities of Vietnam, increased extremely serious traffic congestion in recent years due to the economic growth has led to increased air pollution, deteriorated amenities, and reduced accessibility to urban services. The current situation calls for the development of a comprehensive urban public transport system. In addition, Hanoi's population jumped from about 2.7 million in 2000 to about 3.2 million in 2006 (and is expected to reach 4.5 million in 2020), resulting in a dramatic increase in traffic volume on city roads and severe traffic congestion. This impedes efficient socio-economic activity. Given the difficulty in significantly expanding the transport capacity of existing public transportation and road networks, a new urban mass rapid transit system is required to be built to ease traffic congestion and air pollution. Therefore, Vietnam's Master Plan for Railway Construction (2002) aims to modernize its rail transport, including facilities and railway cars, by 2020, raise speed and increase the share of railway transport in means of transportation overall. Specifically, the plan aspires for railways to account for 20% or more of all urban transportation in Hanoi and Ho Chi Minh by 2020. Moreover, given the lack of transportation infrastructure in major cities and importance of measures to combat traffic congestion, the Five-Year Socio-Economic Development Plan (2006-2010) proposes to complete the construction of ring roads and bypasses in major cities and construct an urban railway system in Hanoi and Ho Chi Minh. The plan aims for public transportation to account for 30% of the transportation demand in urban regions. Accordingly, up to 2020, Hanoi and Ho Chi Minh will have 6 metro lines with more than 100 km in total for each as shown in Figure 1.1 and 1.2 (Luu, 2010).

From this background, it is forecasted that a huge quantity of excavated soil will be discharged from the underground construction projects in the two cities over the next decade. Moreover, at present, excavated soils from construction sites are disposing inappropriate due to the shortage of landfill sites in the cities. Whereas, most backfilling

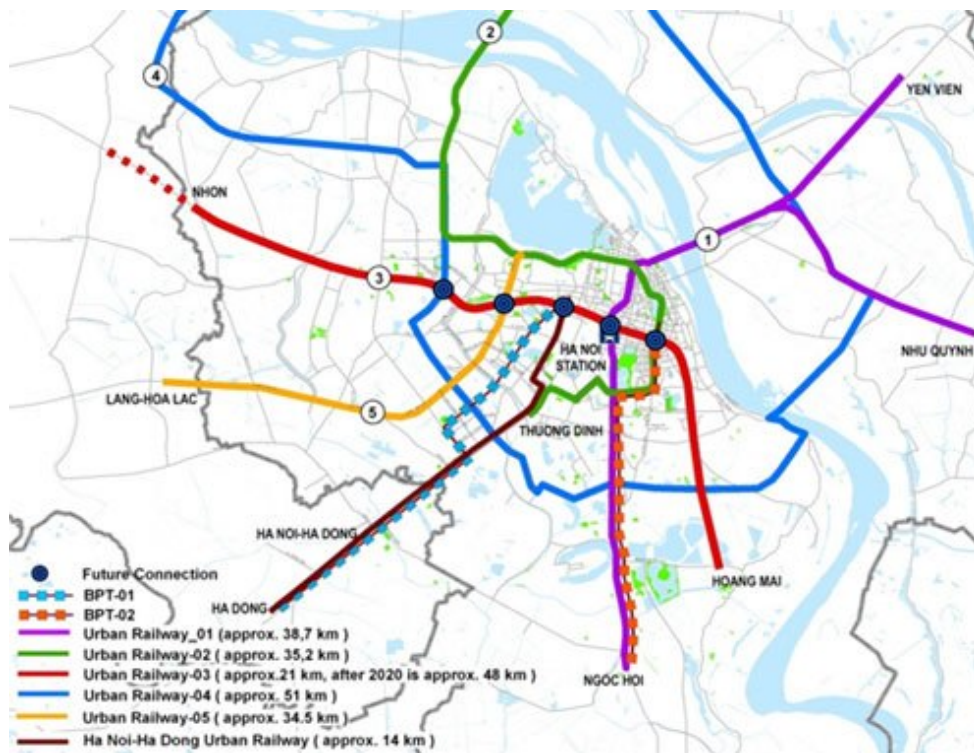


Figure 1.1 Metro route map of Hanoi city up to 2020

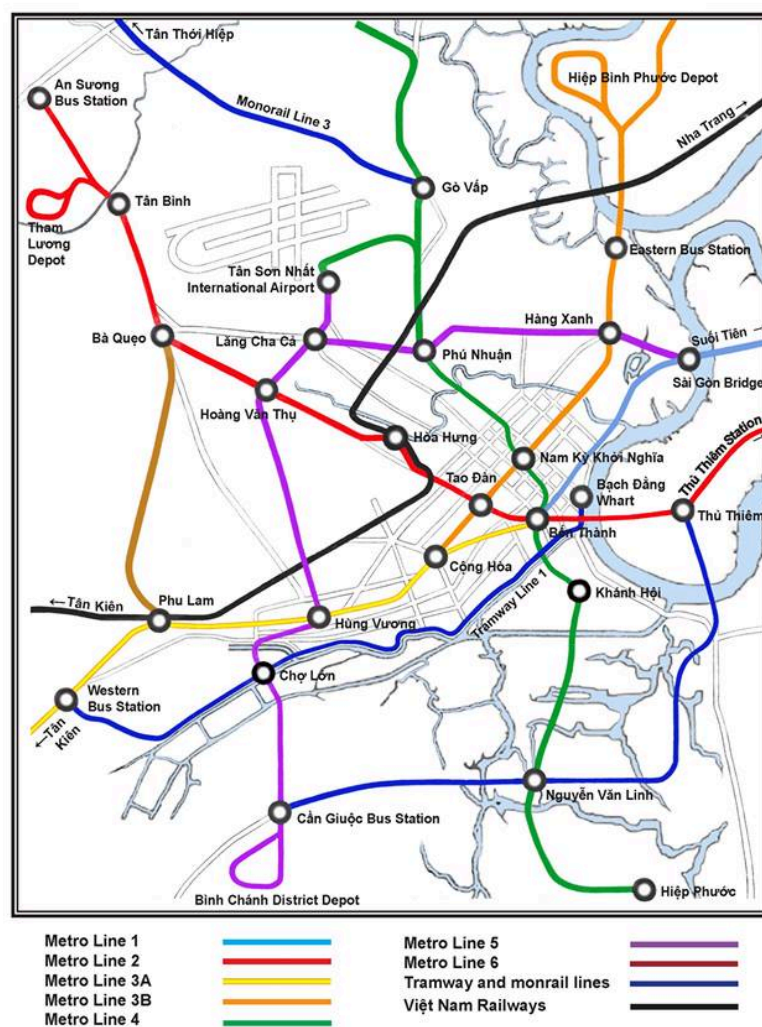


Figure 1.2 Metro route map of Ho Chi Minh city up to 2020

material for construction works is being extracted from natural sources such as sand mining from river and gravel from mountain, which cause significantly negative impact on environment. On the other hand, as the metro system operated, the train-induced vibration from the metro lines will be arisen and annoying to nearby resident. However, up to now a prediction procedure of train-induced vibration from tunnel in conformity with current condition of Vietnam has been not found in official standards or literatures, and then, the ground-borne vibration level are not estimated in environmental impact assessment. Furthermore, in order to predict the ground-borne vibration, the dynamic parameters of soil are known clearly. In Vietnam, however, due to financial difficulties and shortage of testing equipment, lack of the guiding standards for estimation of the parameters.

Liquefied Stabilized Soil (LSS) being used popularly as a recycling methods for excavated soil in Japan, which the soil is mixed with water (or muddy water) and cement stabilizer and reused as backfilling material (Kuno, 1997; JGS, 2005), will be one of the best effective methods to solve the problems of soil generated from tunnel construction sites and shortage of backfilling material together in Vietnam. Moreover, if LSS can be applied as a backfilling material by using excavated soil mixed with cement stabilizer in the projects of cut and cover tunnel to mitigate the train-induced vibration, it will be a new advantage, and then LSS will be promoted more to use especially in metro projects in Vietnam.

1.2 OBJECTIVE AND SCOPES

Based on the results of previous research performed with both LSS using NSF-clay which is fine powder clay bought in Japanese market and Vinh Phuc-Clay which spread in Hanoi area as an original material, it concluded that the strength and deformation behaviors of both LSS tend to be similar (Giang, 2010). This can be seen on Figure 1.3(a) and (b) which show the relationship between deviator stress q ($=\sigma_1 - \sigma_3$) and axial strain ε_a from Consolidated–Undrained triaxial compression tests under confining pressure $\sigma'_c = 98$ kPa of both NSF-Clay and Vinh Phuc-Clay LSS mixed by fibered material content of 0, 10, 20 kg/m³ at 56 days, respectively. The tests were performed under axial strain rate of 0.054 %/min. thus, the behaviors of both LSS is the same. Also, the other results of the research indicated that the physical behaviors of both LSS tend to be similar. Therefore, in this study, to investigate the strength and deformation characteristic of LSS mixed with fiber material, LSS using NSF-Clay was used as a representative of LSS using excavated clay in Hanoi area. On the other hand, to evaluate mitigation of train-induced vibration as using LSS for backfilling ground of cut and cover tunnel in Hanoi city, the available parameters from the previous research of LSS using Vinh Phuc-Clay for analysis model in this study was adopted.

First of all, the effect of curing day on triaxial shear properties at small strain level on various specimens preparing at laboratory was discussed. The influence of time-dependency on strength and deformation characteristics of LSS mixed with fibered material was investigated. On the other hand, three field test pits (1.5 m in length, 0.5 m in width, 0.5 m in depth for one pit), which is model ground, were constructed as back

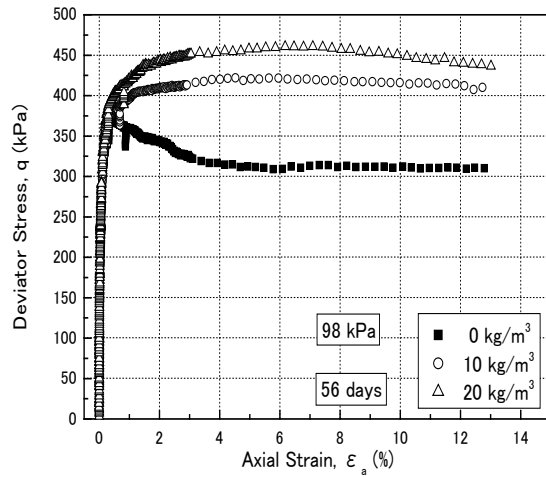


Figure 1.3(a) $q \sim \epsilon_a$ relation of Vinh Phuc-Clay LSS

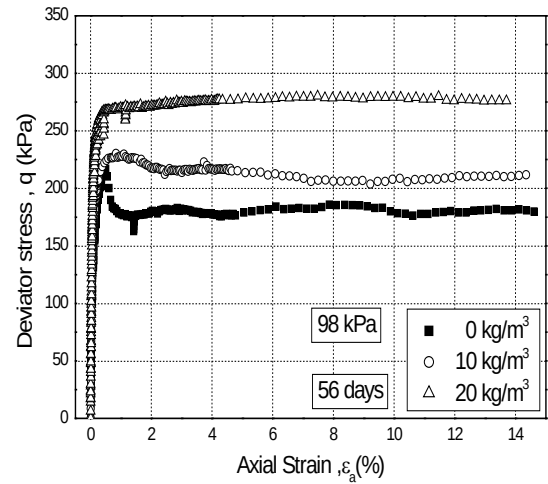


Figure 1.3(b) $q \sim \epsilon_a$ relation of NSF-Clay LSS

filled ground by LSS mixed with fibered material at test field in Muroran-IT campus. These test pits were constructed by LSS mixed with fibered material of different composition. When the laboratory tests will be conducted, the field test by portable Falling Wight Deflectmeter (FWD) was also conducted at the test pits. Then, the in-situ compressive stiffness of the LSS was evaluated and the non-uniformity of back fill ground by LSS mixed with fibered material was discussed by comparing the results between laboratory tests and field tests.

Secondly, methods for estimation of soil dynamic parameters in conformity with current condition of Vietnam was suggested by selectively adopting the methods of previous researches in the world. Then, a procedure for prediction of train-induced vibration from tunnel in Vietnam was fully established. The metro line No.3 in Hanoi currently under construction was selected to analysis for this study. Train-induced dynamic loading on tunnel floor was simulated by means of a train-track-tunnel interaction model. Results of the simulation in term of force time history was input data for tunnel-soil interaction problem. The vibration propagation from the tunnel into the ground surface was analyzed by the 2-dimensional finite element method (FEM). Numerical results from the model in term of vibration velocity allow estimating the vibration velocity level, and then it is applicable to the prediction of train-induced vibration propagated from railway tunnel.

Finally, mitigation of train-induced vibration as using LSS for backfill ground of cut and cover tunnel was evaluated by using the established procedure. Two cases i.e. the use of hill cut soil and LSS as backfilling material for a cut and cover tunnel section of Hanoi metro line No.3 were selected to analyze in this study. Based on the analysis results, the effect of backfilling materials on mitigation of ground vibration caused by moving train on tunnel was evaluated.

1.3 ORGANIZATION OF THESIS

As seen in Figure 1.4, this dissertation contains eight chapters. The introduction (Chapter 1) describes the general background, objectives and scopes of research and organization of the dissertation.

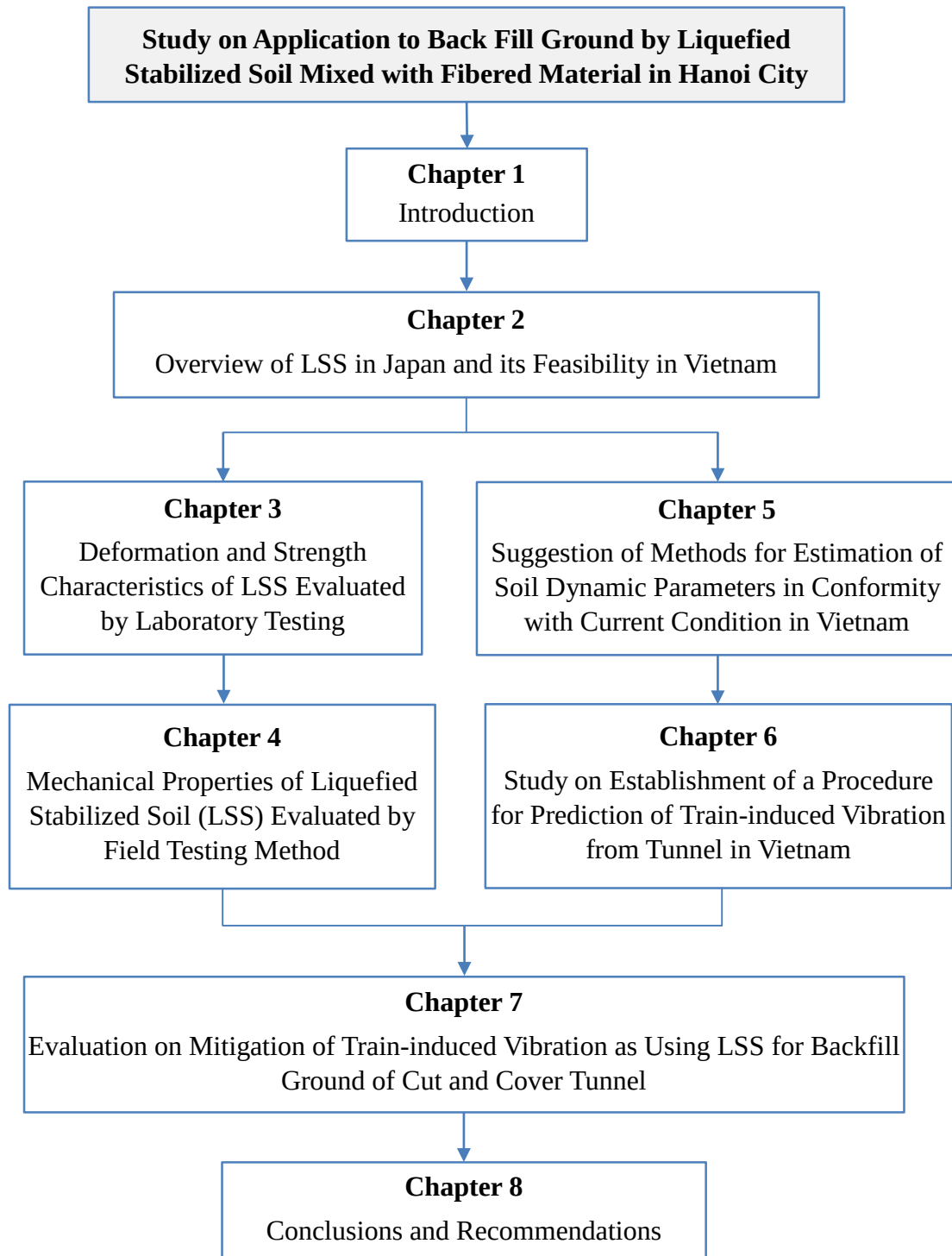


Figure 1.4 Flow chart of this dissertation

Chapter 2 presents an overview of LSS as an effective method for utilization of excavated soil in Japan. The problems regarding excavating works in Vietnam was pointed out and then feasibility for utilization of LSS in Vietnam has been highlighted in this chapter.

Chapter 3 is to investigate deformation and strength characteristics of LSS by laboratory testing. Two experimental works were carried separately. The first one was conducted to evaluate the time-dependency on deformation property of LSS mixed with fibered material, and the second one was performed to investigate the strength and deformation characteristics of LSS reinforced by fiber material prepared at laboratory and field.

Evaluation of in-situ compressive stiffness of ground backfilled by LSS reinforced with fiber is presented in chapter 4. The stiffness was estimated by Young' modulus $E_{p,FWD}$ calculated from measured $K_{p,FWD}$ -value as a coefficient of subgrade reaction by portable FWD. The relationship between the $E_{p,FWD}$ and tangent Young' modulus E_{tan} obtained from triaxial compression test was discussed in this chapter.

Methods for estimation of soil dynamic parameters in conformity with current condition in Vietnam is suggested in chapter 5. Use of the methods in order to estimate soil dynamic parameters for metro line No.3 in Hanoi bring reliable results.

Chapter 6 establishes fully a procedure for prediction of train-induced vibration from tunnel in Vietnam.

Using the established procedure, chapter 7 evaluates the mitigation of train-induced vibration as using LSS for backfill ground of cut and cover tunnel in Hanoi metro line No.3.

Finally, the conclusions drawn from this study and recommendations for future works were given in chapter 8.

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