SETTLEMENT RATE FUNCTION DEVELOPMENT BASED ON FIELD INSTRUMENTATION TEST AND LABORATORY TEST

THESIS

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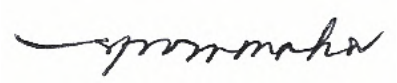

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PERNYATAAN BEBAS PLAGIARISME

Yang bertandatangan di bawah ini, saya dengan data diri sebagai berikut:

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Settlement Rate Function Development Based on Field Instrumentation Test and Laboratory Test

adalah benar-benar karya saya sendiri di bawah bimbingan dosen pembimbing. Saya tidak melakukan penjiplakan atau pengutipan dengan cara-cara yang tidak sesuai dengan etika keilmuan yang berlaku dalam masyarakat keilmuan. Apabila di kemudian hari ditemukan adanya pelanggaran terhadap etika keilmuan karya saya, atau jika ada tuntutan formal atau non formal dari pihak lain berkaitan dengan keaslian karya saya ini, saya siap menanggung segala risiko, akibat, dan/atau sanksi yang dijatuhkan kepada saya, termasuk pembatalan gelar akademik yang saya peroleh dari Universitas Katolik Parahyangan.

Dinyatakan: di Bandung
Tanggal: 20 Agustus 2024

TABITHA ALDRIANITA

PENGEMBANGAN SETTLEMENT RATE FUNCTION BERDASARKAN INSTRUMENTASI LAPANGAN DAN UJI LABORATORIUM

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ABSTRAK

Pada penelitian ini dikembangkan metode Settlement Rate Function (SRF) yang memperhitungkan konsolidasi primer dan kompresi sekunder, dimana pada beberapa jenis tanah lunak memiliki kompresi sekunder yang signfikan. Pengembangan metode SRF dilakukan dengan mengobservasi karakteristik dan perilaku penurunan tanah untuk menghasilkan prediksi penurunan tanah yang akurat. Hasil perhitungan SRF kemudian dibandingkan dengan prediksi penurunan tanah berdasarkan metode Asaoka dan metode konsolidasi satu dimensi oleh Terzaghi. Hasil penelitian menunjukkan SRF dapat memprediksi penurunan tanah cukup akurat dengan menggunakan interval waktu 20 hari dan memisahkan fase konsolidasi primer dan kompresi sekunder. Untuk tanah lunak yang memiliki kompresi sekunder yang signifikan, metode SRF dapat memprediksi penurunan tanah secara akurat selama kompresi sekunder telah muncul saat pengambilan data tanah dan *rate* penurunan tanah tidak fluktuatif.

Kata Kunci: Settlement Rate Function, tanah lunak, kompresi sekunder, *settlement plate,* interval waktu.

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ABSTRACT

In this study, the Settlement Rate Function (SRF) method was developed to account for both primary consolidation and secondary compression, where some types of soft soils exhibit significant secondary compression. The development of the SRF method involved observing the characteristics and behavior of soil settlement to produce accurate predictions of soil settlement. The SRF calculations were then compared with predictions of soil settlement based on the Asaoka method and the one-dimensional consolidation method by Terzaghi. The research results indicate that SRF can predict soil settlement accurately using a 20-day interval and effectively separates the phases of primary consolidation and secondary compression. For soft soils with significant secondary compression, the SRF method can predict soil settlement accurately, provided that secondary compression has occurred by the time soil data is collected and the rate of soil settlement is not fluctuating.

Keywords: Settlement Rate Function, soft soil, secondary compression, settlement plate, time interval.

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Bandung, August 20, 2024

Author

Tabitha

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LIST OF NOTATIONS AND ABBREVATIONS

Notations List

$\Delta\sigma_z'$: Effective stress

$\Delta\sigma_z$: Total stress

Δu : Excess pore pressure

Δt : Time interval

ε_z : Vertical strain

ε_p : Volumetric strain

β : Beta

σ : Stress

σ_z' : Effective vertical stress

γ : Density

φ : Friction angle

c : Cohesion

Cu : Undrained cohesion

C_α : Secondary compression index

C_c : Compression index

C_r : Recompression index

C_v : Coefficient of consolidation

e : Void ratio

fs : Sleeve friction

h : Pressure head

H_{dr} : Drainage path

I : Hydraulic gradient

k : Permeability

m_v : Modulus of volume compressibility

N : SPT blows

R : Settlement rate

S : Settlement

S_c : Primary consolidation

$S_{c(s)}$: Secondary compression

S_f : Final settlement

t : Time

t_p : End of primary consolidation

u : Pore water pressure

qc : Cone tip resistance

V : Volume

v : velocity

Abbreviations List

BH : Borehole

CPTu : Cone Penetration Test

EOP : End of Primary Consolidation

SP : Settlement Plate

SPT : Standard Penetration Test

SRF : Settlement Rate Function

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CHAPTER 1

INTRODUCTION

1.1 Background

The first one-dimensional consolidation theory was stated by Terzaghi, which is the function of settlement versus time. Until this day, Terzaghi's consolidation theory is fervently used in the academic and practical fields.

According to this theory, settlement happens vertically and secondary compression begins after primary consolidation is complete. However, prior research has shown that secondary compression takes place before the end of primary consolidation. Further, it was discovered that some types of soils could have significant secondary compression and can be eminently impactful in long term conditions. Thus, this thesis attempts to predict soil settlements accurately from the field instrumentation test data that takes account of primary consolidation and secondary compression. The method that will be used and developed is Settlement Rate Function and will be compared with Asaoka's method and one-dimensional consolidation method by Terzaghi. Evaluation of the effects of soil condition upon field data retrieving and data utilization impact on soil settlement prediction will be conducted in order to predict more accurately.

1.2 Problem Statement

Terzaghi's consolidation theory assumes that secondary compression starts after primary consolidation ends. In reality, secondary compression could happen

concurrently with primary consolidation. Secondary compression could also be quite significant in some cases. Thus, Settlement prediction methods that consider primary consolidation and secondary compression accurately are needed to obtain better prediction results.

1.3 Research Hypothesis

The Settlement Rate Function can be developed from the settlement rate versus time curve which has variables that take primary consolidation and secondary compression into account. The length of the settlement observation duration input determines the settlement prediction produced by the Settlement Rate Function, and the minimum length of observation time required to produce reliable results can be determined.

1.4 Research Purpose and Objectives

The objectives of this research is:

1. Analyze the settlement behavior based on the field instrumentation data.
2. Evaluate the effects of soil condition upon retrieving and data utilization impact on settlement predictions.
3. Determine the final settlement prediction using Settlement Rate Function.
4. Compare the predicted result with one-dimensional consolidation method and Asaoka's method.

The purpose of this research is to determine soil settlement calculation method that takes account of secondary compression and predicts settlement accurately.

1.5 Research Scopes

The scopes of this research are:

1. Conduct literature studies related to soil settlement theories and prior settlement prediction researches.
2. Develop Settlement Rate Function for fine-grained soil in Gelora Bandung Lautan Api Stadium.
3. Compare predicted Settlement Rate Function result with one-dimensional consolidation method and Asaoka's method result.

1.6 Thesis Outlines

1. CHAPTER 1 Introduction

   This chapter comprises background, problem statement, research hypothesis, research purpose and objectives, research scopes, and thesis outline.

2. CHAPTER 2 Literature Review

   This chapter points out theories about embankment, soil characteristic and parameter, soil consolidation, and settlement calculation procedure.

3. CHAPTER 3 Methodology

   This chapter defines the analysis procedures and Settlement Rate Function development.

4. CHAPTER 4 Data Analysis

   This chapter describes soil data analysis procedures, settlement calculation procedures and results using Terzaghi's one dimensional consolidation theory and Settlement Rate Function method development.

5. CHAPTER 5 Conclusions

This chapter defines the conclusion based on the analysis and hypothesis testing results and as well as author's recommendations for supporting future research.

1.7 Flow Diagram

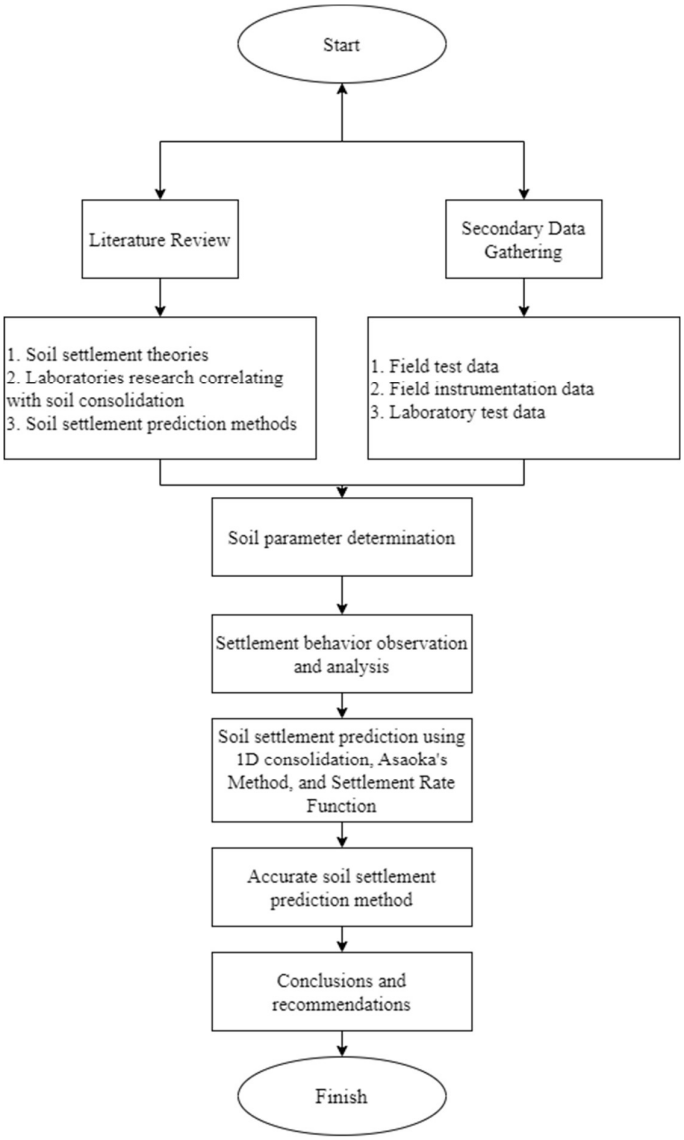

Figure 1.1 Flow Diagram