CHAPTER I

INTRODUCTION

1.1 Background

Reinforced earth (RE) wall has been known since 1971 in the United States and the construction of reinforced earth wall has been very popular lately in the application of a retaining wall. Many benefits are obtained when we choose to use RE wall, besides the low price, easy application, and good durability, RE wall also proven has a good performance for extreme loading conditions (Durukan, Zeynep; Tezcan, Semih S. 1992). In terms of sustainability, this wall can also be considered to be one of the best wall in case of environmental, economic, and social/functional sustainability compared to conventional gravity or cantilever wall (Damians, Bathurst, Adroguer, Josa, & Lloret, 2018). However, designing the RE wall has many factors to be considered, such as the material for the designing the wall structure. On RE walls, soil-reinforcement interaction mechanism is a very important factor that must be considered, the mechanism will plays a big role when the wall receives extreme loads. Soil-reinforcement interaction mechanism is strongly influenced by the material properties used to build the RE wall, such as soil and the reinforcement which will determine the performance of the RE wall (Touahmia, 2014).

Sand is one of the constituent components of a wall that has an important role. The soil used to build RE wall is usually granular material such as sand, because it has good interlocking behaviour. This behaviour will increase the friction between

the soil and reinforcement, in this case is the geotextile. Although sand has good interlocking behaviour, there are many types of sand, and the properties in each type of sand is varies. A clear example that will affect the soil-reinforcement interaction mechanism is fines contents in the sand. One way to study the effect of fines content of sand in civil engineering is to do parametric study on pull-out test (Hegde & Roy, 2018).

Many pull-out tests have been carried out by researchers to study the soil behaviours. Pull-out testing has also been done numerically by using various finite element software. Numerical studies using finite element method (FEM) are considered more economical, faster, and the result tend to be more rigorous than laboratory test. In this study, the author will check the accuracy of the numerical study conducted by Hegde & Roy in 2018 and study the effect of fines content in sand. Numerical modelling will be done in the same software and the results will be used as validation. The output of this study is a graph of the pull-out force comparison with its displacement carried out by Hegde & Roy (2018) with the results from author.

1.2 Research Formulation

Sand is one of the granular materials that are often used in construction, especially in the construction of retaining walls. However, there are many types of sand that can be utilized in construction, and each type has different properties. In the construction of a RE wall, soil-reinforcement interaction mechanism is a very important factor to determine the performance of the wall. This mechanism is

heavily influenced by the course and fines content in sand. In this study, author will examine the pull-out test conducted by Hegde & Roy (2018) using the Finite Element Method (FEM), in the form of pull-out test force and its displacement. Numerical modeling will be executed in the same Finite Element software, namely Plaxis 2D.

1.3 Research Objectivity

To validate the pull-out test procedure conducted by Hegde & Roy (2018) and calibrate the numerical simulation of pull-out test with Mohr-Coulomb model using Plaxis 2D in study of fines content in sand on soil-geosynthetics interaction.

1.4 Research Limitation

In the study conducted in this report, the following research limitations were set below:

1. Validation is done using the same finite element software, Plaxis 2D.
2. Numerical simulations carried out in this study is using Mohr-Coulumb model.
3. This study only validates the results of the pull-out test.
4. This study only using one type of geotextile.
5. The modeling in this study has been validated using the laboratory result conducted by previous research.
6. The output of this study is pull-out force graph and its displacement.

7. The analysis on effect of fines content in sand is only based on the result of conducted pull-out test.

1.5 Research Benefit

The results of this final project study are expected to make readers know the effects of fines content in sand toward the soil-reinforcement interaction mechanism. In addition, it is expected that this study can be a reference in conducting numerical modeling and parametric study, so the research using numerical simulations can be done accurately and provide precise predictions, same as the results obtained in laboratory tests.

1.6 Originality

Dennes and Jin (1994) has carried out laboratory tests that predict the pull-out resistance of polymer-grid reinforcement. They compared using Tensar grid (SS2 and SR80) to be used in some backfill soil conditions. There were 3 types of backfill soil used in its research, first is weathered clay, second is sand ($\emptyset = 35°$), and the third is sand ($\emptyset = 40°$). The loading of normal force is also varied, so the study for pull-out force - displacement relationship of reinforcement can be solved in detail.

A.C.C.F. Sieira et al. (2009) has conducted a test laboratory that studies the load transfer mechanism on a geogrid. Tests are carried out using two types of geogrids and two types of soil. The test carried out was a direct shear test and pull-out test, each test was given a varying normal force.

V. Prashanth et al. (2016) have carried out laboratory tests to observe that pull-out behavior is strongly influenced by normal stress and the type of geosynthetics used. The results of the study are the load response of each geosynthetic material, based on different loading.

Hegde & Roy (2018), has done a numerical study on the interaction between soil and geosynthetic by using a large scale direct shear test and pull-out test. Studies conducted on the effects of fines content in sand on soil-reinforcement interaction mechanism. Parametric studies are carried out using three types of sand which have different fines content (0%, 20%, and 40% fines content). The results of this study show how much is the influence of fines content in sand toward sand-geosynthetics interfaces interaction.

Based on several studies conducted, almost all of researchers studied the behavior of geosynthetics, not specifically considering the soil properties as Hegde & Roy have done (2018). The study to validate the results of the pull-out test conducted by Hegde & Roy (2018) using a finite element method has never been done. With this, the author believes that the study was carried out original and not an act of plagiarism from several studies that have been done before.