UNIVERSITI TEKNOLOGI MARA

CREEP PULLOUT MECHANICAL BEHAVIOUR OF V-ARMED HYBRID ANCHOR SOIL NAIL IN SLOPE STABILISATION

MOHAMMAD ASHARI BIN MUDA

Thesis submitted in fulfillment
of the requirements for the degree of
Doctor of Philosophy
(Civil Engineering)

College of Engineering

August 2022

ABSTRACT

Various slope stabilisation and landslide protection methods are available to combat landslide risk. Soil nailing is a soil reinforcement technique or mechanical technique that provides internal stability to reinforce the slope post construction and during excavation. It is widely implemented due to the simplicity of construction and it is economical. However, there are shortcomings in the system based on many failures reported by the authorities. One of the shortcomings in the conventional soil nails is the creep behaviour in the pullout resistance force i.e., the pre-stressed tension diminishes when slippage between the nails and the surrounding soil occurs. Creep occurs when the nail is pre-stressed; it elongates and is followed by longitudinal movement towards the bearing plate thus lead to the loss of tension. This research focused on the bond resistance, shape and failure mechanism of the V-Arm Hybrid Anchor due to creep effect. The V-Arm Hybrid Anchor System is a mechanical anchor head connecting with the rebar and has a locking system that can grip at the end of the rebar. This research was conducted in Malaysian soil to evaluate the performance of the soil reinforcement in Malaysian condition i.e., tropics, high weathering rate, soil invariants etc. The soil laboratory tests were carried out to determine the characteristic of the soil and its relating strength parameters. Field tests were executed to evaluate the performance of hybrid soil nail system in reducing creep and its performance in various soil conditions. The triaxial tests were carried out to determine soil shear strength in unsoaked and soaked conditions. The slope stability analysis was simulated in GeoStudio Slope/W and Slope Rain to illustrate the effect of soaking to the shear strength of the soil. The pullout test and monitoring were conducted on two (2) numbers of soil nails for each selected site. The nails tested consist of one (1) number of nails attached with the V-armed flip anchor system and one (1) number using the conventional soil nail system where both systems are fully grouted. The shear strength degradation due to soaking is substantiated where non-linear envelopes are considered. The pullout tests with stress monitoring using strain gauges were conducted and the results showed that the high stresses were developed at the nail head and at the anchor tip of hybrid anchor. These implicated that the hybrid anchor system can provide additional passive stress resistance at both ends of the soil nails. Thus, applying a hybrid anchor minimizes the displacement due to pullout stress and is in accordance with the guidelines stipulated in FHWA and Geo 7. The creep performances for both types of soil nail systems are presented, and the results showed that the V-Armed Hybrid Anchor has the ability to restrain creep.

ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious and the Most Merciful. Alhamdulillah, all praises to Allah and His blessing for the completion of this thesis. Thanks to Allah for His mercy, opportunities, and guidance in giving me full strength to complete this thesis writing. My humblest gratitude to the holy Prophet Muhammad (peace be upon him) whose way of life has been a continuous guidance for me.

First and foremost, my big appreciation goes to my supervisor, Assoc. Prof Dr. Hj. Mohd Jamaluddin Bin Md. Noor, for his marvellous supervision, guidance and encouragement. Sincere gratitude is extended to his generous participation in guiding, constructive feedback, kind support, and advice during my PhD. Also, I greatly appreciate my co-supervisors, Ir. Dr. Ismacahyadi Bagus Bin Mohamed Jais and Ts. Dr. Adnan Bin Derahman for their great feedback, excellent encouragement and guidance. In preparation of my sampling test, I had to take the help and guidance of some laboratory technicians, who deserve my deepest gratitude, Mohd Akhbar Bin Abdul Hamid, Muhamad Fuad Bin Ahmad and Nor Haidi Bin Mat Saud for their kind assistance.

I would like to extend my warmest gratitude to Jabatan Perkhidmatan Awam Malaysia for awarding me Hadiah Latihan Persekutuan Fellowship, providing me with the financial means to complete this study. Special thanks to my colleagues for helping me with this study especially to all staff of Public Work Department (JKR) from Cawangan Kejuruteraan Cerun, Cawangan Dasar Pengurusan Korporat and JKR Hulu Langat, because of their contribution and support. I extend my thanks to all my friends, for their time, advice and moral support.

Last, but not least, my warm and heartfelt thanks go to the one I love, my mother, Minah Binti Awang, my siblings, my wife, Fadini Binti Mohamad Razali and my children, Nur Asfa Adlina, Nur Asfa Adriana, Muhammad Asfa Adli and Muhammad Asfa Aariz for their du`a, support, motivation and patience for me to achieve my goals in this research. Without that hope, this thesis would not have been possible. Thank you all for the strength you gave me. I love you all!

Finally, this thesis is dedicated to the loving memory of my very dear late father, Muda Bin Mamat for the vision and determination to educate me. Without him, I would not have achieved this honour. This piece of victory is dedicated to you. Al-Fatihah.

TABLE OF CONTENTS