ENGINEERING GEOLOGICAL INVESTIGATIONS FOR PILE FOUNDATIONS ON A DEEPLY WEATHERED GRANITIC ROCK IN HONG KONG

ÉTUDES GÉOLOGIQUES POUR FONDATIONS PAR PIEUX DANS UN GRANITE PROFONDÉMENT ALTÉRÉ À HONG KONG

IRFAN T.Y.* and POWELL G.E.*, Geotechnical Control Office, Hong Kong

Summary

In weathered rocks the determination of founding depth for the foundations of major structures is complicated by the highly variable nature of the material. In order to ensure that the properties of the soil or rock mass on which the structure is to be founded correspond to those assumed in design it is necessary to unambiguously characterise the mass.

This paper outlines a scheme used to characterise the weathered rock mass and describes the engineering geological logging of the large diameter pile foundations on a deeply weathered granodiorite for a series of bridges in the New Territories, Hong Kong. The results of field and laboratory index and engineering tests carried out to determine the characteristics of the foundation rock are discussed. The drawbacks of use of RQD, percentage core recovery or probing tests as a means of determining and proving founding depth of piles are also discussed.

1. Introduction

In weathered rocks the determination of founding depth for major structures is complicated by the highly variable nature of the material. The variability results not only from the nature and intensity of discontinuities, but also from the degree and type of weathering, complicated by faulting, dyke intrusion and hydrothermal alteration.

In order to ensure that the properties of the soil or rock mass on which the structure is to be founded correspond to those assumed in design it is necessary to unambiguously characterise the mass. To do so requires a full appreciation and understanding of the role of the geological factors involved (Kulhawy and Goodman, 1980). Detailed geological mapping and description of the rock mass aided by suitable index testing on representative rock samples allows the information gained from a limited number of high quality, expensive or time consuming tests to be applied at other locations with similar rock mass characteristics.

A series of five bridges, founded on 148 large diameter piles, are being constructed as part of the New Territories Trunk Road, near North Tai Po, Hong Kong (Fig. 1). Advance piles were carefully logged and tested to obtain data and correlations to aid the engineer in arriving at a decision on a suitable founding depth.

This paper outlines the system, based on BS 5930, used to characterise the weathered rock mass and describes the engineering geological logging of the pile foundations on Tai Po granodiorite. The results of field and laboratory index and engineering tests carried out to determine the characteristics of the foundation rock are discussed.

2. Background

The rocks of Hong Kong, predominantly granites and volcanics, have been weathered by dominantly chemical processes under Hong Kong's humid subtropical climate (Ruxton and Berry, 1957) to great depths, typically...
20 to 40 m whilst 90 to 100 m have been reported. The 'rockhead' is variable in most instances and where complicated by faulting, dyke intrusion or hydrothermal alteration the depth to rockhead may vary considerable within a distance of a few metres. Prediction of bedrock level during the preliminary site investigation stage based on a limited number of boreholes is difficult and requires the services of an experienced engineering geologist who is familiar with the site and the regional geological setting. In addition to irregular rockhead levels, corestones of up to 6-7 m diameter may be present within the weathered soil mantle. These may be mistaken for rockhead.

In Hong Kong, foundations for high load structures are traditionally taken to "massive crystalline rock in sound condition" using presumptive allowable bearing stress of 5 MPa in line with the Building (Construction) Regulations (Government of Hong Kong, 1976). RQD values of 75%, or core recovery of 85%, have commonly been specified to define founding depth.

In weathered rocks RQD does not provide a reliable measure of the engineering properties since it fails to take into account the extent and state of the weathered products, and in highly fractured rock may lead to unduly conservative founding depths being adopted. Core recovery is highly dependent on the drilling method and operator technique employed. With modern coring methods 100% core recovery can be obtained at any level within the weathered profile (Brand and Phillipson, 1984) and so the method is extremely limited as a guide to rock mass properties.

A commonly used procedure for formation of deep pile foundations in Hong Kong is to hand excavate the pile, placing concrete rings as the work progresses. The work is normally carried out by a husband and wife team.