Talk on "Fundamental Mechanisms of Loose Fill Slope Failures and Stabilisation Measures"

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On 6 November, 2006, the Geotechnical Technical Division of IEM and JKR Cawangan Jalan jointly organized a talk by Professor Charles W.W. Ng at the Dewan Serbaguna Tan Sri Mahfuz Khalid (Block C), Kompleks Kerja Raya Malaysia, Kuala Lumpur. Professor Charles is Professor of Civil Engineering and Director of Geotechnical Centrifuge Facility at Hong Kong University of Science and Technology. He is a Chartered Civil Engineer (C.Eng.) and a Fellow of the Hong Kong Institution of Engineers (FHKIE). He obtained his PhD from the University of Bristol, UK in 1992.

Professor Charles explained that he carried out extensive research on the topic of "Fundamental Mechanisms of Loose Fill Slope Failures and Stabilisation Measures" over the last few years, primarily to understand whether soil nails can be applied effectively to stabilised loose fill slopes.

1. Static Liquefaction

It is frequently observed that soil mass come down "like a carpet" during landslide for loose fill slopes. The term "static liquefaction" has been adopted to describe loose fill slope failure with long traveling distance. However, static liquefaction of a loose fill slope is very difficult (if not impossible) to be verified and proven in the field since reliable pore pressure measurements and videos are extremely difficult to obtain at the time of failure. It is probable that the terminology "static liquefaction" has been misused very often for failed slopes as strain-softening is necessary but not sufficient condition to generate static liquefaction flow slide.

2. Centrifuge Model

In this presentation, the mechanisms of a loose fill slope failure due to static liquefied and non-liquefied failed fill slopes were demonstrated via centrifuge models tests. The tests revealed that a liquefaction flow slide was initiated by seepage induce failure (and / or reduction of suction) and then followed by undrained collapse for loose sand slopes.

Prof. Charles dispelling some myths on slope failure

In CDG (completely decomposed granitic soils), the reduction of suction due to rainfall only leads to mainly vertical settlements but cannot induce liquefied flow slides. Normal non-liquefied flowslide is possible. CDV fill slopes are even less vulnerable (volcanic soils with more fines content).

Model tests also show that soil nails together with facings can be used as stabilising measures for loose CDG fill slopes. The stabilising mechanism involves the transfer of the out-of-balance force generated from the potential failure mass to the pull out resistance of the soil nails at deeper ground. The use of nails reduces the degree of mobilisation of the soil / shear strain developed. The structural facing transfers the out-of-balance force to the toe support.

3. Field Test

A fully instrumented field test of loose CDG fill slope has similar conclusions as derived from the centrifuge model tests. The slope remained intact and no sign of static liquefaction and flowslide were observed.

The 100 participants were visibly impressed with the research work carried out which has involved many years of detailed effort. The Chairman of the session, Tn. Hj. Ramlee Othman (JKR) concluded the session with thanks to the Professor for volunteering his time and expense to share his knowledge with Malaysian engineers. Prof Charles kindly presented to IEM a CD entitled "Physical Modeling in Geotechnics" (available in IEM library). ■

Prof. Charles receiving a momento from Engr. Hj. Ramlee Othman