ITACET Foundation
Foundation for Education and Training on Tunnelling and Underground Space Use

NANYANG TECHNOLOGICAL UNIVERSITY
Nanyang Centre for Underground Space (NCUS)

ITA AITES

Singapore - Thursday 11th – Friday 12th of July 2013

Underground Space Facilities: Layout, Design and Operational Issues

The purpose of this course is to aid future owners and designers of underground spaces to create well-planned, attractive and functional underground facilities that are safe, secure and cost-effective in terms of life cycle performance. The course is aimed at professionals that do not have significant experience with underground structures but wish to understand in general terms the key related issues. For most of the lecture topics, the ITA offers a full course that can be taken to gain more insight and detail regarding that specific topic. The emphasis of the course is on “facilities” either in soil or rock rather than road or rail tunnel projects and is planned to encompass the design of large integrated underground spaces as well as individual underground facilities.

This particular course is designed to have a half-day focus on the underground space development activities in Singapore. This will include a presentation on a conceptual master planning for underground space use in the Nanyang Technological University campus as well as discussion of recent underground space use projects in Singapore and ongoing national planning and feasibility study efforts. Concentrating this discussion into a half-day will allow appropriate government personnel to be invited to participate in this session.

The course will be given principally by 3 lecturers: Dr. Jian Zhao from EPFL, Switzerland, Dr. Ray Sterling, Louisiana Tech University, USA and John Carmody from the University of Minnesota, USA. It is proposed that Dr. Yingxin ZHOU be included as a presenter in the Focus on Singapore session.

Day one, Thursday morning

Course Introduction: Professor Zhiye ZHAO, Professor, Nanyang Technological University

Focus on Singapore

History of Underground Space Planning in Singapore (Jian ZHAO)

This lecture will present the evolution of interest in underground space use in Singapore and early underground space use studies.

Recent Underground Space Use Developments in Singapore (Yingxin ZHOU)

This lecture will present the current focus of underground space development efforts in Singapore, including oil storage, utilidors, mass transit, and industrial use co-location concepts.

NTU Space Needs, Opportunities and Geology (Jian ZHAO)

An introduction to why NTU is considering underground space use and to its geologic setting.
NTU Master Planning Process and Conceptual Master Plan (John CARMODY)

A presentation of the conceptual master plan development, underground space issues for the NTU campus and solutions generated with presentation of the overall plans and images, etc. for the various types of facilities

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Worldwide Underground Space Use (Ray STERLING)

This lecture will extend the morning discussion to provide a worldwide context for the increase in the use of underground facilities and will include a wide range of international examples.

Preliminary Design Approaches for Underground Facilities (Jian ZHAO)

This lecture will cover the main topographic, geographic and geological conditions that will shape the choice of type of underground facility, facility layout, construction approach and facility cost.

Architectural Design of Underground Facilities (John CARMODY)

This lecture will emphasize the approaches and issues that allow an underground space to be accepted positively by its users/visitors. Issues covered will include facility image and access, wayfinding, spatial configurations, lighting, interior design and materials, etc.

Day two, Friday morning

Energy Use and HVAC Design for Underground Facilities (Ray STERLING)

This lecture will discuss the calculation of energy use in underground facilities and the special design requirements for insulation and HVAC design that will allow low energy use coupled with good temperature, humidity and condensation control. An emphasis in the course will be given to the climatic conditions of the host country. Design approaches will be described in principle but will not be presented in detail.

Urban Environmental Issues for Underground Projects (Jian ZHAO)

This lecture will discuss the key environmental issues for underground projects in urban environments both in construction and operation. Particularly important during construction can be noise, vibration and muck removal. During operations, safety and security issues are important along with the impact on neighborhoods at portals and ventilation points.

Life and Fire Safety and Design for Resilience (Ray STERLING)

This lecture will present the key design concepts for all underground spaces but will focus on the design for life and fire safety and resilience in two types of facility: large multi-user interconnected spaces such as underground shopping centers and large cavern complexes with limit opportunities for surface connections.

Sustainability Issues in Underground Facilities (John CARMODY)

Exploration of sustainability issues for the built environment and particularly in connection with underground space use.

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Day two, Friday afternoon

Waterproofing and Drainage (Ray STERLING)

This lecture will cover the key issues, materials, design details and specifications that are used to control surface and groundwater entry into underground spaces. Water/moisture problems in underground facilities are very difficult to mitigate once they appear in a completed structure, so the emphasis in this lecture is on prevention by proper design and construction supervision.

Site Investigation and Geotechnical Risk (Jian ZHAO)

This lecture will introduce the normal site investigation procedures for different types of underground projects and more specialized techniques that can be used for particular conditions. The relationship between site investigation and project risk will also be discussed.

Operation, Repair, Life Cycle Asset Management (Ray STERLING)

This lecture will explore the operational aspects of underground facilities (other than the HVAC/energy issue). The focus will be on features in various types of underground facilities that require special attention. Different types of underground facilities will be looked at as examples: e.g. downtown pedestrian interconnection systems, rock cavern facilities, utility tunnels and deep cut-and-cover facilities. International examples of operational issues that have developed will be discussed.

Contractual Approaches (Jian ZHAO)

This lecture will cover international practices that are particularly important for underground works including contractual approaches, risk sharing rationales/models and reduction of litigation.

Course Wrap Up

Discussions, questions and answers