"1 Day Post Conference Course (CONCET 2014) on Life Cycle of Concrete Structures"

by Ir.Prof. Dr Jeffrey Chiang

Ir.Prof.Dr Jeffrey Chiang is currently IEM Honorary Treasurer, and he has previously served as IEM Honorary Secretary, Chairman of IEM Civil & Structural Engineering Technical Division, Chairman of IEM-SWO Technical Committee on Wind Loads, as well as Secretary of IEM-SWO Technical Committee on Eurocode 2 Concrete Structures Design.

Background

On 15 August 2014, IEM organised a 1-Day Post Conference Course, as part of CONCET2014 jointly organized by IEM with UM and UiTM.

The invited speaker was Professor Tamon Ueda from the Division of Engineering and Policy for Sustainable Environment, of Hokkaido University, Japan and the course was well attended by over 70 participants.

Prof. Ueda obtained his Doctorate of Engineering from Tokyo University in 1982, and his research interests are in numerical analysis of concrete and hybrid structures, prediction of life cycle of structures, upgrading of structures, seismic design and structural design methodology.

He is active in international collaboration through his membership and contributions in International Federation for Structural Concrete (*fib*) and being the current President of Asian Concrete Federation (ACF).

The outline of the course includes *Life cycle and structural performance* and *material deterioration mechanism and modelling (Frost damage, Fatigue, Combined effect)*.

The lecture focused in addressing some key questions: What is service life, What deterioration (damage) would determine the example of service life, How can the example of service life be predicted, What are deteriorated or damaged structures and the deterioration factors and What does "Life Cycle" of structures mean?

The required performance of structures in performance-based design concept includes Safety, Serviceability, Maintainability and reparability, Constructability, Sustainability (Environmentability) and Economy.

There was an in-class discussion on the question "What is the likely limit state beyond which a structure may not satisfy the requirement to the structure due to some deterioration reason?"

The other topic of discussion was on damage to structures due to freezing and thawing cycles. This occurs in Japan which is one of the most vulnerable areas to frost damage in the world, especially during the winter season.

The following are observed damages to concrete elements due to frost: Cracking – induced by pressure due to freezing water; Scaling – pieces of concrete coming off near the surface; and Pop out – concrete pieces dislodged leaving pock-marks in surface.

The effect of frost damages on material property is the reduction in stiffness and strength.

Likewise the performance of structures will be affected in the following manner: Failure of good appearance; Failure of serviceability and strength; and Failure of durability due to deterioration of permeability through concrete cover.

Prof. Ueda suggested methods to detect frost damages in concrete structures by determining frost damage depth via relative dynamic elastic modulus or RDEM (less than 100%), using ultra sonic wave speed which is a form of non-destructive test).

This is elaborated through modelling for frost damage as well as experimental work on small mortar specimens in meso scale.

He went to describe in detail the results obtained and the discussion that followed in meso scale behaviour of the concrete specimens, categorized into three deformation models: expansion due to freeze thaw cycle; contraction due to freeze thaw cycle; and thermal expansion and contraction.

There followed an in-class discussion revolving around the questions raised:

- What are the other deterioration phenomena affected by frost damage?
- Which material property in macro scale is affected by freeze thaw cycle?
- What kind of change in material in meso scale can explain the above material property change in macro scale?

The last two topics covered by Prof Ueda involves the deterioration of concrete structures due to fatigue and then on the combined effects. The use of S-N curve and the application of endurance or fatigue limits come into play, moving on to study of creep effect. The obvious types of failure encountered are punching shear failure of RC bridge deck, and the enhance chloride ion ingress by the physical damage from frost and mechanical loading induced effects.

The course duly ended on time at 5.00 pm, after a round of question and answer session with the participants. The C&S Technical Division through the session chairman, Ir Prof Dr Jeffrey Chiang thanked Professor Tamon Ueda for his very informative and enlightening course.