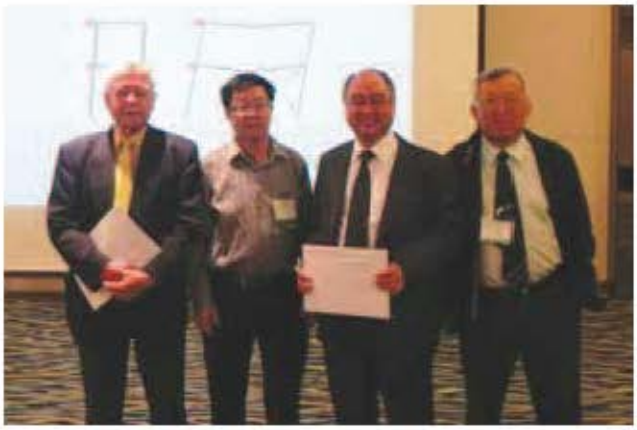
Sequel to a Two-Day Course on Analysis and Design to EC8 Demystified

CIVIL AND STRUCTURAL ENGINEERING TECHNICAL DIVISION

by Ir. Ong Sang Woh



(From left to right) Ir. MC Hee, Ir. Ong Sang Woh, Assoc. Prof. Dr Nelson Lam and Ir. Mun Kwai Peng

THE Two-Day Course on Analysis and Design to EC8 Demystified' is the sequel to the EC8 Demystified course held earlier on 2 and 3 November 2011. This follow-up course was organised by the Civil & Structural Engineering Technical Division of The Institution of Engineers, Malaysia (IEM). The event was held on 5 and 6 November 2012 at Armada Hotel, Petaling Jaya. It was attended by 60 participants.

The first speaker, Associate Professor Dr Nelson Lam began by presenting an overview of the fundamentals of Earthquake Basics and Seismic Design with emphasis on the earthquake loading model proposed for Peninsular Malaysia. Other topics presented during the course were the Concepts & Computational Principles of Dynamic Analyses, Deformation Modelling of Reinforced Concrete and push-over analysis.

Associate Professor Dr Nelson Lam from the University of Melbourne, Australia is an internationally recognised expert in earthquake engineering and structural dynamics who has served as member of the sub-committee for developing the new standard for Earthquake Actions in Australia. He has published 200 technical articles with regards to earthquake engineering and structural dynamics in journals worldwide.

The second speaker Ir. M C Hee presented his lecture on Operating Dynamic Analyses of Buildings, Design of RC Buildings for Ductility Class Medium Classification and Operating Push-Over Analyses of Buildings.

Ir. M.C. Hee is a practicing Structural Consulting Engineer and a Principal of M C Hee & Associates. His expertise is in the design and construction of high-rise buildings particularly in value engineering and alternative design as well as the promotion of strut and tie applications in structural engineering. He is an active member of the technical committee drafting the Malaysian National Annex of Eurocode 8.

The following is a listing of the major topics (i.e. first 3 topics presented by Associate Professor Dr Nelson Lam) covered on the first day of the course:

i. Earthquake Basics and Introduction to Seismic Design

The fundamentals of seismic activity of the World, presence of high stresses in the earth crust (hypocentre and epicentre) and fault lines as planes of weakness, Elastic Rebound Theory, map of Tectonic Plates and seismicity from Offshore of Peninsular Malaysia were explained. The earthquake ground motions in relation to peak ground acceleration (PGA), peak ground velocity (PGV) and peak ground displacement (PGD) together with the pulse wave duration, natural period of vibration, effects of damping and the acceleration time-history affecting the response of the structure were also emphasised. The response spectrum representing seismic action and the Aseismic Design of Structures with reference to Eurocode 8 for 'No Collapse Requirement and Damage Limitation/Continuous Functionality Requirements' were highlighted.

ii. Earthquake Loading Models Proposed for Peninsular Malaysia

The different forms of response spectra in the acceleration, velocity and displacement formats with respect to time and the inter-relationship formula were shown. These response spectrum models recently developed by the speakers were presented for the prediction of long distance earthquake generated from the offshore of Sumatra and projected local earthquakes generated from within Peninsular Malaysia.

iii. Concepts and Computational Principles of Dynamic Analysis

The response simulations of single-degree-of-freedom systems by Central Difference Method, the Principles of Modal Superposition & Dynamic Equilibrium Basics for frames under 1st, 2nd and 3rd mode responses and the Eigensolutions by Mode Shape Iteration Method for

multi-storey buildings and their co-relationship matrix were covered in detail. The storey displacements, drifts, inertia forces, base shear and effective modal mass together with the Modal Combination were demonstrated with spreadsheet work examples.

iv. Operating Dynamic Analysis of Buildings for Design Office Applications using Simplified-Unified Approach

The speaker Ir. M.C. Hee introduced the simplified-unified approach to reinforced concrete section analysis and design. Flexural and ductility design concepts and formulae, the moment-curvature relationship and the modal response spectrum method analysis to framed-shear-wall buildings were explained. Also, design using Midas-Gen software was demonstrated with interpretation of the results.

Both speakers covered the following topics on the second day of the course:

i. Design of Reinforced Concrete Buildings of DCM Classification

Ir. M.C. Hee went through the EC8 definition and detailing of various structural elements such as beam, column, wall and ductile wall, structural systems and local ductility with reference to Capacity Design for strong column-weak beam concept. The P-Delta effects on secondary column, joints detailing, geometric constraints for walls and an example of capacity design were illustrated using both hand and computer methods.

ii. Concepts and Principles of Deformation Modelling of Reinforced Concrete

Associate Professor Dr Nelson Lam introduced the fundamental concept of deformation modeling and its adaptation to displacement-based seismic design of structures. The concepts of estimating drift and ultimate drift at yield by hand calculations, deformation modeling by fibre analysis and the method of estimating the beneficial effects of confinement were explained. The estimation of deflection for reinforced concrete elements in both the pre-yield (cracked) and post-yield conditions (at the plastic hinges) were also presented with worked examples.

iii. Concepts and Computational Principles of Push-Over Analysis

The Capacity Spectrum Method and the use of the Accelerated-Displacement Response Spectrum (ADRS) Diagram involving the Push-Over Analysis can be an effective method in predicting the seismic performance of low-medium rise buildings. This method was illustrated by example of single and two-storey moment frame buildings basing on linear elastic behaviour and also for framed structure after formation of plastic hinges. The application of matrix computation and the list of detailed considerations for push-over analysis were highlighted.

iv. Operating Push-Over Analysis of Buildings for Design Office Applications

The operational details of push-over analysis by hand computation was shown based on practical case studies of buildings. Also, computer simulations using Midas-Gen software were demonstrated for comparison and the results were interpreted.

Overall, participants were introduced to the fundamentals of Seismicity on earthquake ground motions (PGA, PGV, PGD and intensities), natural periods and damping, response to a single pulse, and response spectrum. The Capacity Spectrum Method involving the push-over analysis for predicting the seismic performance of low-medium rise buildings was introduced. Examples of hand and computer modelling of building structures to EC 8 were also discussed.

Finally, before the two-day course was concluded, a token of appreciation was presented to each of the speakers, namely Associate Professor Dr Nelson Lam and Ir. M.C. Hee. ■

Ir. **Ong Sang Woh** is currently the Chairman of the Civil & Structural Engineering Technical Division, IEM.