Proceedings of the
Second International Conference on Sustainable Urbanization

7-9 January 2015
Hong Kong, China

ICSU 2015
Proceedings of the
Second International Conference on Sustainable Urbanization (ICSU 2015)

7-9 January 2015, Hong Kong, China

Edited by
J.G. Teng
The Hong Kong Polytechnic University

Organised by
Research Institute for Sustainable Urban Development &
Faculty of Construction and Environment
The Hong Kong Polytechnic University
CO-ORGANISERS:  Research Institute for Sustainable Urban Development, and
Faculty of Construction and Environment
The Hong Kong Polytechnic University

INTERNATIONAL ADVISORY COMMITTEE

Prof. Chimay Anumba  Penn State University  USA
Prof. Lawrence C. Bank  US National Science Foundation  USA
Dr Helen Bao  University of Cambridge  UK
Prof. Eugenie L. Birch  The University of Pennsylvania  USA
Prof. Mark Bradford  The University of New South Wales  Australia
Prof. Guy Brasseur  Climate Service Center  Germany
Prof. Jian-fei Chen  Queen's University Belfast  UK
Ir Tai Chong Chew  MTR Corporation Limited  Hong Kong, China
Prof. Manfred Ehlers  University of Osnabrueck  Germany
Prof. Dongping Fang  Tsinghua University  China
Prof. Dan M. Frangopol  Lehigh University  USA
Prof. Nabil F. Grace  Lawrence Technological University  USA
Prof. Hongguang Jin  Chinese Academy of Sciences  China
Ir Edmund K H Leung  Kowloon-Canton Railway Corporation  Hong Kong, China
Prof. Zongjin Li  Hong Kong University of Science and Technology  Hong Kong, China
Prof. Patrizia Lombardi  Politecnico di Torino  Italy
Prof. Robert Melchers  University of Newcastle  Australia
Prof. Perry McCarty  Stanford University  USA
Prof. Tso-Chien Pan  Nanyang Technological University  Singapore
Ir Dr Otto Poon  ATAL Environmental Engineering  Hong Kong, China
Dr Baoxing Qiu  Chinese Society for Urban Studies  China
Prof. K V Raghavan  Indian Institute of Chemical Technology  India
Prof. Jerald L. Schnoor  The University of Iowa  USA
Prof. Shu Tao  Peking University  China
Prof. Shuoxian Wu  South China University of Technology  China
**CONFERENCE ORGANISING COMMITTEE**

**Chairman:**
Ir Prof. Jin-Guang TENG  
The Hong Kong Polytechnic University

**Members:**
- Prof. Xiao-li Ding  
The Hong Kong Polytechnic University
- Prof. Jan Ming Ko  
The Hong Kong Polytechnic University
- Prof. Xiang-dong Li  
The Hong Kong Polytechnic University
- Prof. Geoffrey Q.P. Shen  
The Hong Kong Polytechnic University
- Prof. Hong-xing Yang  
The Hong Kong Polytechnic University

**Organizing Committee of Symposium 1:**
**Chairman:**
Prof. Jin-Guang Teng

**Members:**
- Dr T.M. Chan
- Dr J.G. Dai
- Dr Z. Leng
- Prof. Y.Q. Ni
- Dr Y.H. Wang
- Dr Y. Xia
- Prof. J.H. Yin
- Dr S.Y. Zhu

**Organizing Committee of Symposium 2:**
**Chairman:**
Prof. Geoffrey Q.P. Shen

**Members:**
- Prof. William Lam
- Prof. Edwin Chan
- Prof. Eddie Hui

**Organizing Committee of Symposium 3:**
**Chairman:**
Prof. Xiang-dong Li

**Members:**
- Prof. Wei Chu
- Dr Henry Lee
- Prof. Xiangzhong Li
- Dr Ben Leu
- Dr Dan Tsang

**Organizing Committee of Symposium 4:**
**Chairman:**
Prof. Xiao-li Ding

**Members:**
- Prof. J.N. Cao
- Prof. W. Chen
- Dr W. Lai
- Dr Z.Z. Liu
- Prof. W.Z. Shi
- Dr M.S. wong
- Dr B. Wu
- Dr L. Zhang

**Organizing Committee of Symposium 5:**
**Chairman:**
Prof. Hong-xing Yang

**Members:**
- Dr M. Ni
- Prof. J.L. Niu
- Prof. S.C. Lee
- Prof. S.W. Wang
- Dr L. Lu
- Dr F. Xiao
PREFACE

The First International Conference on Sustainable Urbanization (ICSU 2010), organized by the Faculty of Construction and Land Use of The Hong Kong Polytechnic University (PolyU), was held on 15-17 December 2010. This second conference (ICSU 2015), co-organized by the Research Institute for Sustainable Urban Development (RISUD) and the Faculty of Construction and Environment (FCE) (previously the Faculty of Construction and Land Use) as a sequel to the first conference, was held on 7-9 January 2015 on the campus of PolyU. The conference series aims to provide a forum for the international scientific/engineering community to examine challenges brought about by massive urbanization and to find effective solutions to ensure a sustainable process of urbanization.

To facilitate more focused discussions, ICSU 2015 was organized into five symposia focused on the following five distinct themes: (1) emerging materials and technologies for sustainable infrastructure (chaired by Prof. J.G. Teng); (2) sustainable urban renewal in high-density cities (chaired by Prof. Geoffrey Q.P. Shen); (3) sustainable water in cities (chaired by Prof. X.D. Li); (4) urban data and urban computing (chaired by Prof. X.L. Ding); (5) energy saving and renewable energy technologies for buildings (chaired by Prof. H.X. Yang). In addition, ICSU 2015 incorporated as its sixth symposium the Second Cross-Strait Forum on Sustainable Urban Development, which was chaired by Prof. J.M. Ko, Senior Advisor of RISUD.

The presentations given at the conference included: (a) plenary keynote lectures; (b) symposium keynote lectures; (c) invited presentations; and (d) presentations at special sessions; and (e) presentations arising from free submissions. Altogether, the conference programme included over 220 presentations, and their abstracts are included in this volume of proceedings. All abstracts submitted to the conference were peer-reviewed to ensure quality and relevance. The submissions came from 28 countries around the world and covered a wide range of issues within the broad field of sustainable urban development.

The organization of this conference was a significant challenge due to the diversity of topics and reflected the dedicated support from many individuals and organizations. The Organizing Committee of the conference comprised the five chairs of the symposia and the chair of the forum. A Symposium Organizing Committee led by the symposium chair was set up to support the organization of each symposium. As Chairman of the Organizing Committee, I am indebted to all colleagues who served as chairs or members of the five Symposium Organizing Committees. Special thanks go to Prof. J.M. Ko, who offered great help throughout the process of organizing the conference and who kindly agreed to chair the Cross-Strait Forum on Sustainable Urban Development.

On behalf of the Organizing Committee, I would like to thank all presenters, particularly the Keynote and Invited Speakers for sharing their work, experience and insight at the conference. The International Advisory Committee generated widespread interest in and support for the conference both within and outside Hong Kong. We are grateful to them for their important contributions to the conference. The conference has received financial support from the Construction Industry Council and Gammon Construction Ltd, while the Cross-Strait Forum on Sustainable Urban Development was financially supported by a donation from Dr Samuel Yin via the Kwang-Hua Education Foundation. The generosity of these three organizations is acknowledged with heartfelt gratitude.

The conference was co-organized by RISUD and FCE. The Conference Secretariat comprised of staff from both units: Ms Y. Tsui, Ms Emily Choi, Ms Liz Lau, Ms Mickey Pat, Mr Jason Au and Ms Stephey Pang. Thanks are due to Prof. Y.L. Xu, Dean of FCE, for his strong support for the conference and to all members of the Conference Secretariat for their dedication. Special thanks are due to Ms Emily Choi of the RISUD office, who worked highly effectively and efficiently over many long and busy days to ensure that the conference could be successfully organized.
Professor Timothy W. Tong, President of PolyU, opened the Conference on 7 January 2015. I am grateful to him and the wider community of the university for the support and encouragement we received in the course of organizing this conference.

Prof. J.G. Teng,
Chair of the Organizing Committee of ICSU 2015 &
Director of Research Institute for Sustainable Urban Development
The Hong Kong Polytechnic University, Hong Kong, China
# Table of Contents

**International Advisory Committee**

**Conference Organising Committee**

**Preface**

**Table of Contents**

<table>
<thead>
<tr>
<th>Plenary Keynote Lectures</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>THREE MODELS OF LOW CARBON ECO-CITIES</td>
<td>2</td>
</tr>
<tr>
<td><em>Baoxing Qiu</em></td>
<td></td>
</tr>
<tr>
<td>PROSPECT OF DISTRIBUTED ENERGY SYSTEMS</td>
<td>3</td>
</tr>
<tr>
<td><em>Hongguang Jin</em></td>
<td></td>
</tr>
<tr>
<td>ALTERNATIVE APPROACHES FOR WATER, ENERGY, AND NUTRIENT RECOVERY FROM DOMESTIC WASTEWATER</td>
<td>4</td>
</tr>
<tr>
<td><em>Perry L. McCarty</em></td>
<td></td>
</tr>
<tr>
<td>URBAN WATER SUSTAINABILITY AND CLIMATE CHANGE</td>
<td>5</td>
</tr>
<tr>
<td><em>Jerald L. Schnoor</em></td>
<td></td>
</tr>
<tr>
<td>TRANSITION TO LOW CARBON ENERGY (LCE) REGIME: ENGINEERING CHALLENGES IN URBAN BUILDING AND TRANSPORT SECTORS</td>
<td>6</td>
</tr>
<tr>
<td><em>K. V. Raghavan</em></td>
<td></td>
</tr>
<tr>
<td>BUILDING RETROFITS – A KEY COMPONENT OF SUSTAINABLE URBAN RENEWAL</td>
<td>7</td>
</tr>
<tr>
<td><em>Chimay J. Anumba</em></td>
<td></td>
</tr>
<tr>
<td>THE GREEN DECK PROJECT - AN INNOVATIVE SOLUTION TO ENHANCE THE ENVIRONMENT</td>
<td>8</td>
</tr>
<tr>
<td><em>Alex Lui</em></td>
<td></td>
</tr>
</tbody>
</table>
A STATE-OF-ART REVIEW OF PLASTIC HINGE LENGTH MODEL FOR RC COLUMNS
C. Jiang, Y. C. Chan, X. Feng and Y. F. Wu

STRUCTURAL PERFORMANCE OF ALKALI-ACTIVATED SLAG MORTAR THIN PANELS REINFORCED WITH BASALT TEXTILES
J. G. Dai, Y. Ding, T. Li and Y. M. Zhang

RECENT DEVELOPMENT OF CONSTRUCTION AND BUILDING MATERIALS AT THE NANO AND ADVANCED MATERIALS INSTITUTE (NAMI)
T. C. Ling, Ivan M. L. Sham, B. Li and K. T. Wan

EARLY-AGE THERMAL CRACKING IN CONCRETE
V. T. N. Dao

COMPARISON OF ENVIRONMENTAL PERFORMANCE OF STEEL AND REINFORCED CONCRETE BUILDINGS BY LINEAR AND NONLINEAR ANALYSIS
H. Yu and S. L. Chan

PERFORMANCE INVESTIGATIONS OF REINFORCED MAGNESIUM PHOSPHATE CONCRETE BEAM UNDER ACCELERATED CORROSION CONDITIONS BY MULTITECHNIQUES
H. F. Pei, Z. J. Li and J. R. Zhang

METALLIC CORROSION IN THE POLLUTED URBAN ATMOSPHERE OF HONG KONG
Hai Guo and Bo Liu

EXPERIMENTAL STUDY ON FIBER REINFORCED CEMENTITIOUS MATRIX CONFINED CONCRETE COLUMNS UNDER AXIAL COMPRESSION
Lan Zeng, Lijuan Li and Feng Liu

A NEW TIME-DEPENDENT MODEL FOR THE EROSION DEPTH OF SULFATE TO CONCRETE
Y. W. Zhou, T. Hao, L. L. Sui and F. Xing

New Materials for Sustainable Structures

THE PROPERTIES OF ALKALI ACTIVATED SLAG INCORPORATED WITH NANO MATERIALS (Invited Presentation)
Y. M. Zhang, L. Y. Yang, T. Li, C. H. Deng and J. G. Dai

MANUFACTURE AND CHARACTERIZATION OF CARBON NANOTUBE REINFORCED HIERARCHICAL, MULTIFUNCTIONAL COMPOSITES
Jialai Wang, Xinyu Zhang and Will Guin

PHOTOCATALYTIC NOX REMOVAL OF CONCRETE SURFACE LAYERS INTERMIXED AND SPRAY-COATED WITH NANO-TIO2: INFLUENCE OF ENVIRONMENTAL FACTORS
M. Z. Guo and C. S. Poon

IMPROVED SOUND INSULATION PROPERTIES OF LIGHT WEIGHT RUBBERIZED CONCRETE DUE TO PRETREATMENT OF RUBBER AGGREGATE
Binyun Zhang and Chi Sun Poon
EARLY-AGE THERMAL CRACKING IN CONCRETE

V.T.N Dao
School of Civil Engineering, The University of Queensland, Brisbane, Australia. Email: v.dao@uq.edu.au

ABSTRACT

Early-age thermal cracking in concrete structures is a persistent problem that has caused ongoing great concerns for the construction industry. This form of early cracking and its further development at later ages can seriously compromise the integrity, durability, aesthetics, and long-term service life of wide-ranging types of concrete structures. Effective control of early-age thermal cracking is thus of great economic significance.

Despite significant research over the past decades, our effort to control such cracking has been hindered by a lack of holistic understanding of the key phenomena and factors underlying the behaviour of early-age concrete. This paper first reviews the crack formation mechanism and major influencing factors, including properties of concrete constituents, ambient conditions, and curing measures. A novel insight into the influence of zero-stress temperature $T_z$ (being the temperature at which concrete stress due to restrained thermal deformation is zero) on concrete cracking is then presented:

It is argued that the concrete tensile stress due to restrained thermal deformation can be determined by $\sigma_t = K R E_c \alpha_c \Delta T$: The larger the $\Delta T = T_z - T$, the higher the resulting tensile stress and hence more crack-control reinforcement required. Accordingly, whether $T_z$ remains largely constant or decreases over time would have significantly different implications on the role of early thermal control: If $T_z$ remains constant over time, reducing $T_z$ during construction by adopting appropriate mix designs and construction practices is of paramount importance; otherwise, significant crack-control reinforcement is required. On the other hand, if $T_z$ decreases over time, the resulting tensile stress and thus requirement for controlling $T_z$ during construction and for crack-control reinforcement might be significantly less. Currently, however, how $T_z$ evolves over time after concrete placement and factors influencing this evolvement are still unknown.

Following a detailed discussion of this critical knowledge gap and its implication, ongoing research to examine the significance of $T_z$ in crack control and quantify its effects on cracking risk is briefed, the outcomes of which are expected to lead to more effective control of thermal cracking in early-age concrete.

KEYWORDS

Concrete, early-age, thermal cracking, zero-stress temperature.