9th Asia Pacific Conference on Transportation & the Environment

6th to 8th August 2014
Colombo,Sri Lanka

PROCEEDINGS

Transportation Engineering Division
Department of Civil Engineering,University of Moratuwa

Conference Proceedings

9th Asia Pacific Conference on Transportation and the Environment

APTE9-2014

6th - 8th August 2014

Mount Lavinia Hotel

Colombo, Sri Lanka

9th Asia Pacific Conference on Transportation and The Environment

ISBN 978-955-9027-44-7

Published by
Transportation Engineering Division
Department of Civil Engineering
University of Moratuwa
Sri Lanka
August 2014

Tel: +94 11 2650567/8 Ext (2023)
Fax: 2651216
Email: apte9.conf@gmail.com
Web: http://apte9.weebly.com

Editor
Dr. H. R. Pasindu

Contents

Session B1 (6th Aug) – Travel Demand & Traffic Analysis

Session A2 (6th Aug) – Pavement Performance

Session B2 (6th Aug) – Pedestrians & Road Safety

Session A3 (7th Aug) – Accident Analysis & Road User Behaviour

Session B3 (7th Aug) – Transport & Environment

Session B4 (7th Aug) – Highway Planning & Materials

Session B5 (7th Aug) – Transport Operations

Message from the Head, Department of Civil Engineering, University of Moratuwa

Prof. Anura Nanayakkara

Head, Department of Civil Engineering,

University of Moratuwa

It gives me great pleasure to send this message on the occasion of the 9th Asia Pacific conference on Transportation and Environment, which is organized by the Transportation Engineering Division of the Department of Civil Engineering, University of Moratuwa.

I learn that the objective of this conference is on environmental issues related to the rapid development of transportation operations and infrastructure development in developing countries in the Asia Pacific region. The conference covers fifteen themes related to all modes of Transportations giving emphasis on environmental issues. The issues that will be discussed in details at the Conference, will be of great importance to the developing countries of the Asia Pacific Region.

I am happy that this year's APTE Conference is held in Sri Lanka and I take this opportunity to welcome the foreign delegates and wish them all success in their deliberations. I believe that this conference will lead to a more active cooperation among researchers in the field of transportation.

I express my sincere appreciation to the organizing committee for their hard work and commitment to make this event a success.

I wish every success of the 9th Asia Pacific Conference on Transportation and Environment.

Message from the Co- Chairman of the Conference Organizing Committee

Prof. Saman Bandara

Co-Chair, 9th Asia Pacific Conference on Transportation & Environment

Transportation Research Forum 2014

It is a great pleasure and honour to have the opportunity to host the 9th Asia Pacific Conference on Transportation & Environment in Sri Lanka, for the first time outside the East Asian region. I take this opportunity, along with the Transportation Engineering Division of the Department of Civil Engineering, University of Moratuwa, Sri Lanka, to warmly welcome all the delegates from around the world.

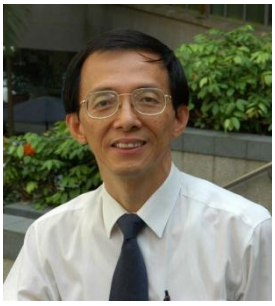
Recent accelerated economic development in the Asia Pacific region has resulted in rapid changes in the transportation systems and has created the need for more opportunities to acquire latest knowledge in the field. Further, transport related developments in many countries of the Asia Pacific region have led to a number of environmental impacts and concerns over the likely consequences of these impacts. The national and regional transportation infrastructure development and traffic operations in urban centres in particular, require careful planning so as to mitigate the negative social and environmental impacts. Hence, there is a need to have a forum for exchanging experiences in different parts of the world and also to have opportunities to disseminate new knowledge to the society.

Transportation Engineering Division, of the Department of Civil Engineering, University of Moratuwa, Sri Lanka annually organizes its Transportation Forum to share the research knowledge and experience with the industry and organizes an international conference bi annually to connect up with the other part of the world. This year is a unique opportunity to have 9th Asia Pacific Conference on Transportation and Environment along with the Transportation Research Forum 2014. We are very grateful to the Chairman and the members of the International Scientific committee of the Asia Pacific Conference on transportation and

Environment for giving us the opportunity to host the conference in Sri Lanka, "Pearl of the Indian Ocean".

I wish to congratulate the organizers for the wonderful conference and hope this two-day event will generate more interest in professional approach to transportation & environment functions and enthusiasm towards accelerated but sustainable development of transportation industry in the region. We hope you will find the conference productive, informative, and enjoyable. We also wish you a pleasant stay in Sri Lanka and enjoy the rich cultural heritage and romantic landscapes during the post conference visits to Kandy & Sigiriya.

Message from the Chairman of the APTE International Advisory & Scientific Committee



Professor T. F. Fwa

Chairman

APTE International Advisory & Scientific Committee

While transportation has made significant contributions to the progress of mankind both economically and socially, its adverse impacts on the environment and the social well being of the society are also well recognized. The transportation community must take up the responsibility and do our parts to mitigate such adverse impacts. The progress in this aspect has not been all encouraging globally because of economic constraints and factors beyond the control of the transportation sector. Despite these difficulties, we in the transportation community must continue to contribute by promoting sustainable developments and operations in all aspects of the transportation sector. This is an objective of the APTE Conference series which was first launched in Singapore in 1998.

The APTE Conferences encourage the research and applications of environmentally and socially friendly technologies in this part of the world, through interactions and exchange of ideas and experience among the transportation researchers and practitioners. To this end, APTE Conferences actively promote two major tracks of the program, namely a Green Transportation Technology track, and a Traffic and Road Safety track. I am glad to see that the 9th APTE conference continues this tradition in attracting good papers that address these two very critical issues towards achieving sustainable transportation developments in this part of the world.

On the organization of the conference, we thank the Conference Host and the Conference Organizing Committee for the outstanding efforts, and the University of Moratuwa for the great support to make this Conference possible. I believe all participants will benefit from this conference and have an enjoyable stay in Colombo.

International Scientific Committee

- **Professor Fwa Tien Fang**
  National University of Singapore
- **Professor Pichai Taneerananon**
  Prince of Songkla University, Thailand
- **Professor Zhou Wei**
  China Academy of Transportation Sciences, China
- **Professor S. S. Jain**
  Indian Institute of Technology Roorkee, India
- **Professor Yoshitsugu Hayashi**
  Nagoya University, Japan
- **Professor Arun Kumar**
  Queensland University of Technology, Australia
- **Professor S. C. Wong**
  The University of Hong Kong, Hong Kong

The 9th International Academic Committee

- Prof. Amal Kumarage - *University of Moratuwa*
- Prof. Saman Bandara - *University of Moratuwa*
- Dr. W. K. Mamapearachchi- *University of Moratuwa*
- Dr. Namali Sirisoma- *Kothalawala Defence University*
- Dr. Raymond Ong - *National University of Singapore*
- Dr. Farhan Javed - *National University of Singapore*
- Dr. Tan Jun Yew - *Samwoh Corporation Pte. Ltd.*
- Dr. Kelvin Lee- *Samwoh Corporation Pte. Ltd.*
- Dr. H.R. Pasindu - *University of Moratuwa*
- Dr. Habibur Rahman - *Land Transport Authority*
- Dr. Low Boon Hwee - *Ley Choon Group Holdings Limited*
- Dr. Liu Zhiyuan - *Monash University*
- Dr. Ju Fenghua - *Samwoh Corporation Pte. Ltd.*
- Ms. Emiko Lim - *National University of Singapore*

- Dr. T.Sivakumar - *University of Moratuwa*
- Dr.Dimantha De Silva - *HBO Specto Incorporated*
- Dr. Niranga Amarasinghe - *Sri Lanka Institute of Information Technology*
- Dr. Bagus Setiadji - *Dipenogoro University*
- Dr. Yang Jiasheng - *National University of Singapore*
- Dr. Qu Xiabo - *Griffith University*
- Dr. Jaritngam Saruvat - *Prince of Songkla University*
- Mr. Loshaka Perera - *University of Moratuwa*
- Mr. Varuna Adikariwattage - *University of Calgary*
- Mr. Darshana Perera - *University of Wollongong*
- Mr. Aditya Nugroho - *Surbana International Consultants Pte.Ltd.*
- Mr. Zhang Lei - *National University of Singapore*
- Mr. Lakshan Wasage - *Southern Alberta Institute of Technology*

Local Organizing Committee

Chairman	:	Prof. J. M. S. J. Bandara
Co-Chairman	:	Dr. W. K. Mampearachchi
Secretary	:	Dr. H. R. Pasindu
Members	:	Mr. Loshaka Perera Ms. Samanmalee Rathnayaka Mr. Chandana Vipulasena
Conference Assistants	:	Mr. Uditha Galgamuwa Mr. Isuru Gamalath Ms. Dhanushika Gunatilake Ms. Ruksala Jayarathne Ms. Gayani Galappaththi Ms. Chamindi Jayasuriya Ms. Shamain Saparamadu Ms. Chamali Hewawasam Ms. Udya Abesinghe Mr. Nadika Jayasuriya Mr. Kaushan Dewasurendra Mr. Chamod Hettiarachchi Ms. Melani Jayakody Ms. Chaturi Andrahennadi

Keynote Addresses

Prof. S.C.Wong
Professor
Chair of Transportation Engineering
University of Hong Kong

A CONTINUUM MODEL FOR HOUSING ALLOCATION AND TRANSPORTATION EMISSION PROBLEM IN A POLYCENTRIC CITY

The effect of vehicle emissions on the global climate has prompted increasing concern in the past few decades. Housing development patterns determine people's travel behavior and related vehicle emissions. In this study, we consider a hypothetical city with several central business districts (CBDs) serving several classes of road users, which are continuously distributed over the city. The road network is relatively dense and can be approximated as a continuum. We establish a bi-level model to describe the relationships among housing allocation, traffic volume, and CO2 emissions with a continuum modeling approach. At the lower level, the model achieves the user equilibrium condition of a transport system. At the upper level, it optimizes housing allocation to achieve minimum CO2 emissions. The finite element method, Newton-Raphson algorithm, and convex combination approach are applied to solve the constrained optimization problem established in the bi-level model. A numerical example is then given to illustrate the effectiveness and efficiency of the proposed bi-level approach and solution algorithm in modeling transport demand, traffic intensity, and CO2 emissions with an optimized housing development pattern.

Prof. S.C. (Chan) Wirasinghe
Professor of Civil Engineering
Schulich School of Engineering
University of Calgary

MODE TRANSITION IN A PUBLIC TRANSIT CORRIDOR

Public transit has to be a crucial component of the greater passenger transport system if it is to be sustainable. A good level of service balanced with the cost of service needs to be provided if a large proportion of the population is to be encouraged to use transit in both peak and off peak travel. Various modes of transit including para-transit must be used as appropriate based on the demand and level of service factors.

Properties of the common transit modes such as speed and capacity are analysed on the basis of collected data, to allow a first cut at choosing a mode for service in a given route. Issues caused by lack of data are highlighted. It is apparent that modes such as Bus Rapid Transit (BRT), Busways and Light Rail Transit (LRT) have similarities, while Metro is in a class of its own.

The special case of a high demand transit corridor that is currently served by regular buses is considered. The corridor, as it evolves, is to be transitioned with an additional BRT service. The issue is the choice of the bus stops to be served by BRT. An appropriate objective function is proposed and optimised analytically, giving some insights about the parameters of the new combined system. A key component of the above system, indeed any transit system, is the waiting time spent by passengers. A discussion of waiting time related to the type of service, available technology, and location where the waiting take place is provided.

Dr. Manjriker Gunaratne
PhD, PE
Civil and Environmental Engineering
Professor and Department Chair
University of South Florida

NUMERICAL SIMULATION OF SLIDING OF A SMOOTH TIRE ON A ROUGH WET PAVEMENT

A numerical study was performed to estimate the tractive forces developed on a smooth wheel sliding on a randomly rough wet pavement. The model consists of fluid and tire domains incorporating the relevant characteristics of each. Simulation of the fluid domain involves modeling of water by considering principles of mass, momentum and energy conservation eventually resulting in the Reynolds equation. On the other hand, the tire was modeled by a 3D spring model with each radial spring connected to the four adjoining radial springs by four interconnecting tangential springs. The spring coefficients of the radial and interconnecting springs are defined as functions of the tire inflation pressure. The development of the tire traction force model is based on the simultaneous analysis of three aspects: (1) hydrodynamics of thin film fluids; (2) tire deformation characteristics; and (3) the uplift condition. The results of field texture measurements observed using a circular texture (CT) meter were used to generate a normally distributed random pavement profile. Pavement roughness was incorporated in the model by including a random variation in the water film thickness.

Due to its flexible nature tire deformations occur as water pressure builds up against the tire surface. Hence the analytical results of the fluid model must be an input to the analysis of the tire model and vice versa which is identified as a Fluid-Structure Interaction (FSI) problem. FSI analysis is repeated in the combined model until the deformations of the fluid and tire become compatible at the interface. Finally the uplift criterion of the tire is satisfied by balancing the tire load and the uplift load induced by the fluid film. A MATLAB code was

developed using the Finite Difference Method (FDM) for fluid flow and tire models including the FSI conditions.

The results of the numerical model compared well with a preliminary closed form solution for a rectangular plate tapered into the direction of sliding with an infinite width sliding on a flooded smooth surface with a standing water height. A parametric study was also conducted to evaluate the effects of several significant parameters such as standing water film thickness, tire inflation pressure, sliding speed, average roughness height and tire contact width on the induced drag force.

Finally, standard Locked wheel skid tests were performed at a selected site on a wet pavement with an average standing water film thickness of 6.5 mm at four different speeds. The field texture measurements were observed on the test wheel path using a CT meter. The numerical model was used to predict the drag forces under the same standing water film thickness. It was seen that the numerical model under predicted the drag forces perhaps due to its limitation to being able to simulate only laminar conditions whereas in reality, the flow conditions are turbulent on rough pavements. Nevertheless, the program can be used to provide conservative estimates of drag forces during skidding of a tire on an actual pavement.