

Transport Research Forum 2017



Abstracts

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Transportation Engineering Group
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Keynote Speakers' Profiles & Keynote Addresses



Associate Professor Russell G. Thompson
Department of Infrastructure Engineering
University of Melbourne

Russell is an Associate Professor in Transport Engineering as has a Bachelor's Degree in Mathematics (RMIT University), Masters in Transport Engineering (Monash University) and a PhD in Traffic Engineering (The University of Melbourne). For the last 15 years, he has been involved in numerous local freight studies, including the Melbourne's Freight Movement Model and the Victorian Freight and Logistics Plan. Russell is a Team Leader of the Volvo Centre of Excellence in Sustainable Urban Freight Systems and Vice-President of the Institute for City Logistics based in Kyoto. Currently, Russell is actively involved in several urban freight projects in Melbourne including Freight Villages and Loading Dock Booking systems. He is currently supervising research projects involving modelling logistics sprawl, deliveries to towers, road pricing, collaborative freight systems and autonomous freight vehicles.

Russell has contributed to a number of local and international studies relating to urban freight, including the European Union's Best Urban Freight Solutions (BESTUFS) project and the OECD report on urban distribution. He was a founding Director and has been the Vice President of the Institute for City Logistics based in Kyoto since 1999.

Russell has co-authored over 10 books and 100 refereed publications. He recently co-edited a book, "City Logistics: Mapping the Future" (CRC Press, 2015) that presents a range of innovative solutions to increase the efficiency and reduce the impacts of freight in cities.

Keynote Address 1

City Logistics

City Logistics provides an integrated approach for urban goods distribution based on the systems approach. It promotes innovative schemes that reduce the total cost (including economic, social and environmental) of goods movement within cities.

This presentation will outline methods for improving the efficiency and sustainability of urban distribution systems. An overview of a number of city logistics initiatives such as Urban Consolidation Centres (UCCs), Joint Distribution Systems (JDS), loading dock reservation systems, off-hour deliveries and High-Performance Freight Vehicles will be provided. Experiences in implementing City Logistics schemes in Australian, Japanese and European cities will be presented.

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Professor Manjiker Gunaratne
Department of Civil and Environmental Engineering
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Dr. Manjriker Gunaratne is a Professor and the Chair of Department of Civil and Environmental Engineering, University of South Florida, Tampa, United States of America. He is an expert on Geotechnical and Pavement Management. He holds Bachelor of Science in Civil Engineering degree from University of Peradeniya, Sri Lanka, the M. A. Sc. degree in Civil Engineering from the University of British Columbia, Vancouver, BC, Canada and the PhD in Civil Engineering from Purdue University, West Lafayette, IN, United States of America. His areas of expertise are geotechnical and highway engineering. Some of his major research areas are Modelling of soil and pavement material behaviour, Modelling of uncertainty in geotechnical systems using probability methods, Fuzzy sets and neural networks, Application of numerical techniques to pavement design and management, Application of digital imaging and satellite technology to solve geotechnical and pavement engineering problems.

Keynote Address 2

Use of Imaging to Estimate the Optimum Binder Content of Open Graded Friction Course Mixtures

Yolibeth M. Pernia¹ and M. Gunaratne²

The Florida Department of Transportation (FDOT), USA, used to design open-graded friction course (OGFC) mixtures using a pie plate visual drain-down method (FM 5-588). In this method, the optimum asphalt binder content (OBC) is determined based on visual assessment of the asphalt binder drain down (ABD) distribution of three OGFC samples placed in pie plates with pre-determined asphalt binder contents. In order to eliminate the human subjectivity involved in the current *visual* method, an automated method for quantifying the OBC of OGFC mixtures was developed at the University of South Florida based on digital image analysis and concepts of perceptual image coding and neural networks. The first phase of the investigation involved the FM-5-588 based OBC testing of OGFC mixture designs consisting of a large set of samples prepared from a variety of granitic and oolitic limestone aggregate sources used by FDOT. Then the digital images of the pie plates containing samples of the above mixtures were acquired using an imaging setup customized by FDOT. The correlation between relevant digital imaging parameters and the corresponding asphalt binder contents was investigated initially using conventional regression analysis. The next phase involved the development of a perceptual image model using human perception metrics considered to be used in the OBC estimation. A General Regression Neural Network (GRNN) was used to uncover the nonlinear correlation between the selected parameters of pie plate images, the corresponding asphalt binder contents and the visually estimated OBC. GRNN was found to be the most viable method to deal with the multi-dimensional nature of the input test data set originating from each individual OGFC sample that contains asphalt binder contents and imaging parameter information from a set of three pie plates. GRNN was trained by a major part of the database compiled during the first phase. Finally, the prediction results from an independent part of the above database demonstrated that the GRNN model provides an accurate estimation of OBC values.

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1. Traffic Engineering

Guideline to Select Appropriate Locations for Centre Median Openings

H. N. Prasanga¹, H. R. Pasindu²

Abstract

Medians are paved or landscaped areas in the middle of roadways that separate traffic travelling in opposite directions. A raised median with well-designed median openings is one of the most important tools to create a safe and efficient highway system. Moreover, it reflects the degree of access management of the particular highway.

At the moment, it can be clearly identified that many urban roadways in Sri Lanka are being rehabilitated and improved to multi-lane facilities with introducing raised road centre medians. Therefore, the provision of centre median openings for right turns, cross traffic movement & “U” turns is essential.

However, at the moment, there is lack of proper guidelines or a methodology available within road agencies in Sri Lanka to follow when deciding the appropriate locations for median openings of a particular highway. Most of the time frequent changes occur to the initial designs of the centre median and median opening locations due to the unavailability of a proper guideline. Often, there are lots of public requests for new median opening locations and it is very difficult to handle public requests in the absence of a proper guideline resulting delays to the centre median construction, deviating the objective of safety and proper access management. Therefore, this study is focused on developing a suitable guideline for the median opening selection process.

The proposed guideline has been developed based on some of the international access management guidelines and incorporating local considerations. Decision making criteria when justifying median opening locations is somewhat complex in nature since there is no proper legal framework available in Sri Lanka for access management.

Road network connectivity, road safety, traffic efficiency, right turning traffic volume density, the positioning of road side developments is some of the factors which influence the decision for selecting a proper location for median opening. The PTV VISSIM microscopic simulation model was used to optimize the selected median opening locations with respect to travel time and total delay of the road network. Vissim model has been used intensively around the world for such kind of access management experiments.

The median opening selection process is a complex process with regards to our country since we don't have an access management policy. Therefore, it is very important to note that the median opening spacing are site specific and we cannot recommend a general spacing value for a road or a road section. If we go for general spacing values, that may be incorrect to use with the uneven positioning of by roads and different turning movement densities. Therefore, it is very difficult to provide a constant spacing for median openings in our road network. However, we can practice a minimum spacing value depend on functional requirements and safety.

Keywords: Center Medians, Urban Multi-lane highways, Access management, Road safety, Traffic management

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Effects of Road Rehabilitation on Road Safety; Analysis of Accident Trends

M. S. K. T. D. R. Piyasena¹, J.M.S.J. Bandara²

Abstract

The purpose of rehabilitating the existing roads is to increase the level of service for the users. In that case increasing the level of safety of the road is a main concern. However, with the improvements, the resulting high-speed flow of vehicles and the safety issues in road designs cause changes in accident trends in newly rehabilitated roads. Analysing the accident trends helps to identify the contributory factors which cause the changes in accident trends and to eliminate those causes from future designs. Under this study, an analysis of road traffic crashes on selected rehabilitated roads in terms of descriptive statistics was carried out using 'Sri Lanka Police Accident Database' to find the road safety conditions of newly rehabilitated roads. Further with the purpose of an in-depth review of the causes of accidents a stepwise binary logistic regression was carried out on Padeniya - Puttalam road which has been newly rehabilitated in 2007-2009 as a case study.

Keywords: Rehabilitation, Level of safety, Accident trends, Descriptive statistics, Step wise binary logistic regression

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Assessment of Operating Speeds of Rehabilitated Rural Roads with Asphalt Surfacing

D. D. S. Wijeratne¹, W. K. Mampearachchi²

Abstract

In Sri Lanka, rural roads are not specifically designed on technical requirements. Most of the rural roads (C and D classes) have historical backgrounds as being tracks and trails coming even beyond the colonial times. Hence, most of the rural roads in Sri Lanka are almost following the same traces and not designed technically. Nowadays, rural roads are being rehabilitated. So far, those rehabilitation projects underwent with merely construction improvements and proper geometrical improvements have not been adopted. It was found out that the actual speeds can be significantly greater after rehabilitation affecting the safety of road users. The aim of this study was to assess actual operating speeds, posted speed limits and to find design operating speeds that supposed to be after the rehabilitation. Finally, it suggests rational speed limits to rural rehabilitated roads under purview. Most of the rural roads in Sri Lanka haven't posted speed limits specified according to the geometric, road environment and functionality level of the road. The speed limits of 70km/h and 50km/h are the usual speed limits enforced for traffic in arterial roads which are categorized as class A and B. Since the speed limits are not categorized according to the type of the road, above speed limits apply to the rural roads as well. It's hardly been seen that traffic speeds are controlled or monitored by law enforcement on rural roads. Hence the speed choice of the rural road drivers depends on variety of other factors. The 85th percentile speed is taken as the operating speed. This speed has been used as a basis for suggesting rational speed limit since most drivers behave in a safe and reasonable manner and do not want to get into crashes. Also, it encourages drivers to travel at about the same speed. The researchers have studied a number of rehabilitated roads in North Western province in Sri Lanka. Each road is divided into several sections; straight and curved sections. Operating speeds on straight sections were given priority in suggesting rational speed limits. As operating speeds in curves are considerably lower and enforcing lower posted speeds only based on operating speeds on curves for entire road, would not be practical since drivers tend to disrespect the speed limit. The suggested rational speed limit for all the roads under purview is 50 km/h and this speed limit will be overridden to a lesser speed limit at a curved

section based on the operating and design speed. This speed limit should be notified using sign boards and shall be enforced only for the curve itself.

Keywords: Rural roads, 85th Percentile speed, Rational speed limits, Operating speeds, Speed assessment, Speed management

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Motorcycle Accident Analysis in Sri Lanka: A Case Study

S. L. A. Shajith¹, H. R. Pasindu²

Abstract

Motorcycles comprise nearly 30% of the traffic flow on most highways in Sri Lanka. It is a popular mode of transport of the lower middle-income families as well as the youth due to lower transportation costs. However, the rapid increase in motorcycle usage has led to a significant increase in the number of motorcycle related accidents and fatalities. This has resulted in motorcycle riders being amongst the most vulnerable road users on Sri Lanka roads as they have a lack of protection in the case of a crash.

The objective of this study to identify the risk factor involved in motorcycle accidents. Data obtained from police crash records from 2013 to 2016 are used in the analysis. In 2013 motorcycles are responsible for 33% of total fatal accidents but, in 2016, it is increased to 42%. More frequent motorcycle crashes occurred while driving in week days and driving new motorcycles.

More than 77% of riders involved in motorcycle crashes are in-between 16-40 years of age. Nearly 62% of motorcyclists involved in accidents within two years after license issued. 64% of riders had a valid license and 28% did not have a valid license at the time of the accident. 66% of motorcyclist had worn a helmet at the time of the accident and 7% not. Aggressive/negligent driving is the major reason for 51% of motorcycle accidents.

Most of the motorcycle accidents were two vehicle collision which accounts for 88% of the total motorcycle accidents. The total number of casualties was 17,013 where numbers of fatalities, grievous, non-grievous were 1105, 4999 and 10,909 respectively. Fatal accidents account for 7% of the total accidents and grievous, non-grievous and property damage only accidents are 28%, 50% and 15% respectively.

When accidents were analysed in terms of location of the road it was found that nearly three-quarters (73%) of accidents occurred on a stretch of road where no junction within 10 meters and 17 percentage of accidents occurred in T-Junction. Head-on collision accounts for 16% motorcycle accidents and 15% accounts for rear-end collisions. The major collision type leads to fatalities and grievous accidents was Head-on Collision (0120) except for Motorcycle-Cycle

accident and Motorcycle-Pedestrian accident where major collision type was Rear end collision (1120) and Vehicle comes from the straight road hitting the pedestrian crossing the road from left to right (0925) respectively. Nearly Two-Third (63%) of Motorcycle-Pedestrian fatal and grievous accidents occurred in rural areas where 50% of fatal accidents recorded 50 m away from the pedestrian crossings.

Motorcycle-Pedestrian accidents lead to the highest fatality rate of 26% followed by Motorcycle – Lorry 22%, Motorcycle – Cycle 11%, Motorcycle – Dual-purpose vehicle 10%, Motorcycle – Motorcycle 10%, Motorcycle – Private Bus 8%, Motorcycle – Tractor 4%, Motorcycle – Three-Wheeler 3%, Motorcycle – Car 3%, Motorcycle – SLTB Bus 3% respectively.

In two vehicle Motorcycle accidents, 64% of fatalities are motorcyclists, 25% are pedestrians and 11% of them are cyclists.

One major limitation in available accident data is that the Police accident database does not provide sufficient information on the pre – crash factors contributing to accidents such as Human factors, Vehicle factors, Road factors, Pedestrian factor and other factors. The study shows that younger riders are at greater risk of accidents and pedestrian involvement in motorcycle accidents are very high. These offer useful insights to the risk factors relevant to motorcycle user safety and to implementing effective countermeasures to reduce motorcycle related accidents.

Key Words: Road safety, Motor cycles, Accident analysis

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Evaluation of PCU Factors for Two Lane Sub-urban Roads

P. C. I. Kumaratunga¹, H. R. Pasindu²

Abstract

Passenger Car Unit (PCU) or Passenger Car Equivalent (PCE) is defined as the number of passenger cars displaced in the traffic flow by any other vehicle mode under the existing roadway and traffic conditions. PCU value used to convert all non-uniformity of vehicle modes into a common unit and is used to define the capacity of the road. The nature of the traffic on developing countries like Sri Lanka is heterogeneous with wide variation in physical dimensions, weight and dynamic characteristics. Furthermore, the operating characteristics of the road users and the roadway environment also vary.

PCU factors used at present in Sri Lanka have not been reviewed to reflect the present vehicle characteristics and composition, road geometric and surface conditions.

Traffic data were collected using video filming technique to record vehicles in both directions for 2-3 hours during different phases of weekdays on sub-urban two-way two-lane road segments. Study locations are selected based on uniformity of road characteristics and non-obstruction sections to traffic due to bus stops, intersections etc.

In this study, PCU factors were derived using the method proposed by Chandra et al (1995). According to Chandra, PCU factors for different vehicles under mixed traffic condition is directly proportional to the speed ratio and inversely proportional to the space occupancy ratio with respect to the standard design vehicle i.e. a car.

$$PCU_i = \frac{V_c/V_i}{A_c/A_i}$$

V_c – Speed of car

A_c – Projected rectangular area of a car

V_i - Speed of i^{th} type vehicle

A_i - Projected rectangular area of i^{th} type vehicle

The main findings of the study give the PCU factors for 10 vehicle categories. PCU values are similar in the current study and existing literature for ‘Van’ and ‘Medium Commercial Vehicle’ categories. PCU values for above two types are 1.1 and 2.0 respectively. But other categories show a significant variation. The new PCU value for ‘Motorcycle’ and ‘Three-wheeler’ are 0.2 and 0.53 respectively while the existing values for those two categories are 0.5 and 0.75

respectively. This study gives PCU 2.06 for 'Medium Bus' and 3.41 for 'Large Bus'. But the existing values for above two classifications are 1.6 and 2.4 respectively. The new PCU value for 'Small Commercial Vehicles' and 'Large Commercial Vehicles' are 0.97 and 3.36 respectively while the existing values for those two categories are 1.5 and 3.8 respectively. PCU value for the new vehicle category called 'Passenger Car (Small)' is 0.75.

Derived PCU factors can be used for the planning and design purposes of two-way two-lane roads in Sri Lanka. Further research could be carried out to determine PCU factors for Expressways, Multilane highways and Intersections.

Key Words: PCU, PCE, Heterogeneous traffic flow, Highway capacity

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Effect of Traffic Composition on Capacity of Two Lane Roads under Mix Traffic Condition

K.D.Y. Kaushalya¹, J.M.S.J. Bandara²

Abstract

The analysis of traffic performance on two-lane roads is important for planning, design, maintenance, rehabilitation, and operation. Performance evaluation is typically carried out with the capacity analysis for various highway facilities. There are various factors that affect the capacity of a road; lane width, lateral clearance, vehicle composition, existence of intersections, flow speed, drivers and vehicular characteristics, etc. Evaluating the performance of the two-lane roads is not an easy task because of these distinct characteristics associated with these roads. The majority of the Sri Lankan urban and suburban roads have only two lanes. The vehicle composition in Sri Lanka consists of various types of vehicles such as car, three-wheeler, motorcycle, bus, etc. Due to that reason, mixed traffic conditions prevail and it is a major concern in Sri Lanka with respect to highway planning. Thus, determining capacity under the heterogeneous condition is a challenging task.

This research is conducted in order to identify a relationship between vehicle composition and the capacity of two lane roads in Sri Lanka. Ramanayya (1988) designed speed-flow models by running a simulation model, named MORTAB, for different volumes and percentage compositions of vehicle types in India. In order to conduct this research data is collected in nine different two-lane roads within Colombo city and suburbs. The infrared traffic lodger was used to collect traffic data. PCU values for the vehicles were obtained using Chandra's method [*Dynamic PCU and estimation of capacity of urban roads*, Indian Highways, pp. 17-28, (1995)]. The analysis is conducted road wise and vehicle percentage wise. After a regression analysis conducted on speed density curves of several locations, it was identified that Greenshield's model is the optimum model since it generates higher R^2 values which are close to 1 in all the selected locations. The results are then analysed to identify a generalized relationship in vehicle composition and the capacity on two lane roads when all or few of the vehicle types are present.

It is observed that the capacity increases when the car percentage increases. Capacity decreases when the three-wheel percentage increases. The presence of slow moving vehicles reduces the

capacity of a two-lane road. Further evaluation needs to be carried out in the same location for different compositions at the same flow rate also at more locations to evaluate the effect of other vehicle types. More accurate results can be derived in further research.

Keywords: Vehicle composition, Highway capacity, Heterogeneous traffic, Homogeneous traffic, Passenger car unit, Two lane road, The Infra-Red Traffic Logger (TIRTL), Greenshield model

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Level of Service for Low Volume Roads

D.P Lalith Sirisumana¹, H.R. Pasindu²

Abstract

Low volume roads in Sri Lanka are mainly under the purview of Provincial Road Development Authorities or Local councils. These roads often do not conform to design guidelines and are those that have been gradually developed over the years. As a result, travel speeds are very low and there are major safety issues prevalent on these roads. Therefore, there is a need to upgrade these roads. It is imperative that the selection of the roads that are upgraded is done based on an objective and consistent methodology, considering the limited budget for road improvement and the economic impact of road investments.

The study proposes a methodology to evaluate the level of service of low volume road considering the roadway characteristics, to be used to make decisions on prioritizing roads for upgrading. It does not account for the pavement condition of the road, as it would come under the maintenance and rehabilitation programs of the road agency.

Sample roads from Western Province were selected for the development of the methodology. The common issues observed were as follows,

- Vertical alignment, horizontal alignment, pavement thickness and curvature transition does not conform to design guidelines.
- Variability in road width
- Lack of shoulder or poor conditions.
- There is no specified Right of way.
- Inadequate provision of structures
- Lack of passing bays and bus bays.

An inventory surveys were carried out on the selected roads to collect roadway characteristics such as width, shoulder condition, curvature, passing bays, alignment, road furniture and road structures based on the common issues prevalent. A questionnaire survey was carried out with senior engineers in the Provincial Authority to assess a) the relative importance of each of the roadway characteristic, by ranking them and assign a weightage, b) give an overall subjective

assessment (an index value out 100) of the road sections in the sample level of service based on their observations.

From the results of (a) seven key parameters were selected based on the rank and the magnitude of the weightage given by the experts for each parameter and the average weightage given by the experts is assigned to each parameter. A rating system is proposed under each selected parameter considering the variation of its characteristics. For example, the rating assigned for road width would be based on three categories such width less than 5m, 5m-6m, more than 6m. The overall level of service for each road is computed as a weighted index, calculated by multiplying of the weightage assigned to each parameter with the rating given based on the roadway characteristics observed in the inventory survey and summing the weighted values for all the parameters selected.

This is compared with subjective LOS assigned by the expert in (b) for the same road section and the ratings and relative weights for each parameter is adjusted to improve the correlation. The developed equation can be applied to assess the LOS of a road section based on its roadway characteristics.

The proposed methodology offers a simplified objective process for engineers to evaluate the level of service of road network based on roadway characteristics that can be compiled from an inventory survey that requires minimum resources. This can be a useful input to prioritize road upgrading projects in a provincial road network.

Keywords: Level of service, Low volume roads, Highway planning

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Use of Travel Time Data in Transport Planning

S. P. Kumarage¹, G. L. D. I. De Silva², J. M. S. J. Bandara³

Abstract

Urban traffic congestion is one of the most severe problems of everyday life in Metropolitan areas. In an effort to deal with this problem, intelligent transportation systems (ITS) technologies have concentrated in recent years on dealing with urban congestion. One of the most critical aspects of ITS success is the provision of accurate real-time information and short-term predictions of traffic parameters such as traffic volumes, travel speeds and occupancies.

Predicting car travel times along road segments is an increasingly important component of today's car navigation systems. Use of floating car data geospatial inference method. The main objective of the paper is to identify the use of Google travel time data in planning and management of traffic in urban road networks.

On this regard, the possibility of using Google travel time data in identifying spatio-temporal variation of travel on an urban road network was studied. Data mining for travel time data was supported by the Google distance matrix API. Use of travel time data to analyse the efficiency of utilizing traffic management plans was discussed with reference to the pilot project on implementing bus priority lanes for public buses of the Colombo metropolitan area.

Use of travel time data to analyse the efficiency of utilizing traffic management plans was discussed with reference to pilot project on implementing bus priority lanes for public buses of the Colombo metropolitan area and pilot project on reducing traffic congestion in Dehiwala MC which are two pilot projects implemented in the Colombo metropolitan area.

Keywords: Travel-time, Data-mining, Traffic planning, Floating Car Data

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2. Highway Engineering

Impact of Bitumen Content Tolerance Limit on Performance of Asphalt Concrete Pavements

V. Satheeban¹, W. K. Mampearachchi²

Abstract

The development of corrugation along the longitudinal profile is one of the most common distresses in asphalt pavement. Especially road sections with high longitudinal slope, the problem is more severe than sections with a mild slope. This is because the slope decreases average speed of vehicles running upward, so the total loading time increases drastically. On the other hand, vehicles tend to apply brakes when running downward.

The research aims at finding out how asphalt material (Bitumen & aggregates) properties have an impact on corrugation distress in sloped pavements. For this purpose, a recently constructed and heavily trafficked road (Ambepussa, Kurunegala, Dambulla A006) is considered.

The above road has bitumen bleeding and corrugation issues within a short period after construction in some sloped pavement sections.

The standard specification for construction and maintenance of roads and bridges has specified requirement for bitumen content and combined aggregate grading for mix design of asphalt with tolerances. The most common aggregate combined grading is Type 1 and 3 where Type 1 has finer and Type 3 has coarser particles. The gradation is one of the important characteristics of aggregates affecting permanent deformation of hot mix asphalt. The gradients of slopes are usually not considered when selecting the combined grading type for mix design of asphalt.

The specification may be adapted to suit different conditions considering various criteria. For above road project, combined grading Type 1 and the bitumen content percentage by weight of total mix was adapted as +3% where the standard specification states $\pm 3\%$. This leads the asphalt plant production to maintain bitumen content at higher than the design (maintain at 4.9% in the plant though design bitumen content was 4.8%).

The investigations reveal that combined gradation of asphalt mix is towards the lower limits of specification values in corrugated pavement sections although within the tolerance. Further

temperature and traffic loading to have an impact on sloped pavements. The recent traffic counts show that heavily loaded vehicles travel in the affected sections between 10.00 a.m. to 3.00 p.m.

As per the investigation, it is recommended to always adopt Type 3 (Courser) combined grading for asphalt mix design for heavily trafficked roads in steep gradients and curves.

Keywords: Bitumen content, Combined aggregate gradation, tolerances, temperature, AADT, Climate, Marshal Test

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Volumetric Design and Performance Evaluation of Super pave Mixtures for Sri Lankan Conditions

H. A. M. B. Kadurugamuwa¹, W. K. Mampearachchi²

Abstract

With the vigorous development of technology, road construction becomes a vital part of the economy. Roads connect the economic hubs in a country. Asphalt pavements are widely used because of their high strength, smooth surface and good durability.

The most commonly used Asphalt mix design in Sri Lanka is Marshall Mix Design. This Mix design mainly depends on the empirical nature. It is based on data obtained by observations and experiments rather than reliable in situ data. As a result of this, the Marshall Mix design procedure has substantial drawbacks with respect to replicating the real or actual behaviour of asphalt during construction and in actual service conditions. Due to the heavy traffic and increasing tonnage of vehicles, a lot of ruts, cracks and bulges appear in roads constructed according to Marshall Mix design even before the roads reach their service life.

Due to the increased traffic loads and change in climatic conditions enforced US Congress to support a research program to improve durability and performance of the roads. This research program is known as Strategic Highway Research Program or SHRP. One of the principal results from the Strategic Highway Research Program (SHRP) was the SUPERPAVE mix design method. The SUPERPAVE system includes a performance based asphalt binder system, new mix design method, new test procedures and new test equipment. The SUPERPAVE mix design method was designed to replace the Hveem and Marshall methods. The volumetric analysis common to the Hveem and Marshall methods provides the basis for the SUPERPAVE mix design method. The SUPERPAVE system ties asphalt binder and aggregate selection into the mix design process and considers climate conditions as well. The compaction devices from the Hveem and Marshall procedures have been replaced by a gyratory compactor and the compaction effort in mix design is tied to expected traffic.

This research is mainly focused on comparing the volumetric properties and performance of Marshall and SUPERPAVE mix designs. A comprehensive evaluation of the locally available aggregates usually used in Sri Lankan asphalt mix designs was carried out to ensure that these

materials and their gradations conform to the new mix design procedures developed by SUPERPAVE. Here we compare whether the Marshall Mix designs which are used in the Sri Lankan road industry will satisfy the SUPERPAVE criteria. Samples from both mix designs were prepared at the design asphalt contents and they were subjected to a comprehensive mechanical evaluation testing. These tests included indirect tensile test and Wheel track test.

Keywords: SUPERPAVE, Marshall, Indirect tensile test

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Design of Precast Concrete Cover Slab for Pedestrian Walk Ways

C. J. Atapattu¹, W. K. Mampearachchi²

Abstract

Pedestrians need to experience safety, comfort, accessibility, and efficient mobility. Walkways are often needed in rural and suburban areas to provide access to schools, parks, community centres, local businesses, employment centres, transit stops and stations, and residential areas. In some areas, when no sidewalks, walkways, or shared use paths are available, pedestrians might be seen walking on roadside shoulders. Sidewalks and walkways separated from the roadway contribute greatly to pedestrian safety. So whenever possible, it is necessary to furnish a sidewalk or walkway for the safety and convenience of the pedestrians.

In most of the urban areas in Sri Lanka, drain area also has used as a part of the side walk. Sidewalks have constructed with tactiles and interlocking blocks along with precast concrete cover slabs as to cover the drain and for the mobility of pedestrians. This is mainly due to the lack of land. The existing precast concrete cover slab is designed with a hollow at the edge of the slab as to make a lengthy void when two slab panels are interconnected together. So, it helps for surface drainage as well as to carry or handle the slab panel. But the problem is these holes may be a disturbance for the pedestrians as some valuable things may fall through this. After having some reviews from Municipal councils and RDA, it was confirmed that they get about more than 10 inquiries weekly. So, people tend to cover these holes using gunny bags or some other material to avoid these disturbances. Then the storm water will get collected on the roads and the sidewalks and will lead to a flood. So, in this research, my aim is to modify the existing cover slab so as to give a safe and convenient mobility to the pedestrians.

The research presented in this thesis is aimed at designing of cover slab combined with reinforced concrete and porous concrete. Then the problem of draining out storm water and the inconvenient mobility will be solved. A cover slab model is designed using SAP2000 and checked the stress development. Then the sample is casted and tested for strength and permeability at the lab.

Keywords: Community centres, Local businesses, Employment centres, Transit stops, Residential areas, Sidewalks, Walkways, Tactiles, Interlocking blocks, Precast concrete cover slabs, Gunny bags, Reinforced concrete, Porous concrete.

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Design of Semi-Rigid Pavement Based on Volumetric Properties of the Mixture

P. M. A. B. Dissanayake¹, W. K. Mampearachchi²

Abstract

Semi-rigid pavements are manufactured by producing a very open porous asphalt skeleton and filling the voids with selected cementitious grouts. The resultant composites, referred to as "grouted macadams", combine the flexibility of the bituminous component with the strength and rigidity of the cementitious component. Grouted macadams thus combine the best qualities of concrete and asphalt pavements, namely the flexibility and freedom from joints that characterize asphalt and the high static bearing capacity and rutting resistance of concrete. It has gradually become popular internationally for years as a surface layer of those pavements under serious conditions such as road junctions, airport aprons and heavy loading yards. However, it's very significant to penetrate the cementitious grout into the asphalt skeleton to the greatest extent possible to fill out the air voids present in it, to gain above mentioned properties. Therefore, this study is focused on the penetration ability of cementitious grout under various combinations of characteristics of the semi-rigid pavement.

Keywords: Semi-rigid pavements, Porous asphalt skeleton, Cementitious grouts, Grouted macadam, Bearing capacity, Rutting resistance

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Criteria to Identify Optimum Spacing for Service Areas on Southern Expressway Extension

K. W. Kandambi¹, J. M. S. J. Bandara²

Abstract

Many of the accidents happened in Expressways is due to the fatigue and sleepiness of the drivers. In the Southern Expressway, there is only one service area for the entire 142km distance which will be a relief for the long-distance drivers due to non-availability of any other rest area. The research overview is analysing the effectiveness of the existing service area located in Southern Expressway with collected traffic data over a one week period. Analysis carried out in order to identify the number of vehicles stopped at the service area. Several statistical and graphical methods were used to obtain the distribution of operating speeds in each of the expressway section and categorized as vehicles stopped at the service area considering the average speed. The accuracy of the results can be increased with a vehicle survey at the service area. However, categorization according to the speed is more convenient as comparison carried out with several criteria. The main objective of the research is to identify the optimum spacing for the service areas of Southern Expressway and finding the suitable location for the proposed service area in Southern Expressway extension. In order to show the usage of an effective service area, a standard was developed. The number of possible criteria was identified which could be influencing the driver to use the service area and those criteria were weighted by comparing with the standard and the traffic data analysis. Then weighted factor was applied to the distance between service areas and selected interchange and adjusted to obtain an optimum value for the spacing between two service areas which will help to find the suitable location for the proposed service area in Southern Expressway Extension.

Keywords: Southern expressway, Rest area, Optimum Spacing of service areas

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Identifying Effective Brightness Limits for Headlights of Operating Vehicles in Sri Lanka

R. M. S. K. Senarathna¹, G. L. D. I. De Silva²

Abstract

Driving an automobile is primarily a visual task, and vision contributes as much as 90% of the information required to drive (Alexander and Lunenfeld 1990). At night time, the required visibility level of roadway is created artificially by vehicle headlights or street lighting or both. Illuminating roadway using vehicle headlight is the most common method in night time driving, but too much light and improper lighting may result in glare which causes visual discomfort and a diminished ability to see the roadway. In another way, insufficient light causes problems to drivers to see the information needed or potential hazards in the roadway.

There are many different kinds of headlight systems in operating vehicles (imported from various manufacturers of various countries in various time periods) in Sri Lankan roads including the oldest systems and the most upgraded systems. Generally, a halogen headlamp system which is commonly found in Sri Lankan roads is expected to be performed well about 10 years in normal conditions. But the percentage of older vehicles more than 10 years is higher in Sri Lankan roads.

Different organizations all around the world have introduced regulations on vehicle headlights not only to the vehicle manufacturers but also to the drivers. Comparisons show that the current Sri Lankan regulations have not been updated to address the issues. Even though the road surfaces have been improved so that encouraging drivers to drive faster, other factors have not been considerably improved. Therefore, introducing the new regulatory system should be considered to control this vast variety and mitigate the risk and uncomfortable condition. The intention of this research is to identify brightness levels of operating vehicles in Sri Lankan roads based on Federal Motor Vehicle (USA) regulations which may be helpful to above.

The experimental brightness levels of headlights were measured by simulating the testing arrangement at a work station free for night time. The readings were taken in terms of “Lux” and maximum and minimum levels of brightness were identified.

The results of field tests revealed that the majority of operating vehicles have less brightness levels comparing with the minimum brightness level specified in the Federal Motor Vehicle regulation. Further, it was revealed that the most headlights of operating vehicles are miss-aimed and illuminate unnecessary regions which cause inconvenience to the drivers of oncoming vehicles.

Also, it was revealed that the driver's attention on headlight system of their own vehicle is very poor.

Finally, this research suggests introducing regulations to minimize or mitigate adverse effects of headlights by periodically evaluating headlight systems of operating vehicles based on a proper regulatory system in Sri Lanka.

Key words: Headlight, High beam, Low beam, Illumination

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Establishment of Cover Depth Requirement for Utility Pipes in Arterial Roads

O. S. Chathurangani¹, W. K. Mampearachchi²

Abstract

Pipelines are a safe and economical means of transporting water, gas, sewage and other fluids. They are usually buried in the ground to provide protection. Among those utilities, water lines play a vital role in supplying water to the public. These lines are mainly located under the carriageway of major roads. Therefore, a failure of a critical pipeline is extremely serious and has major consequences in terms of economic loss, social impacts and environmental issues.

The failure modes of the pipeline differ depending on the level of applied external loads, operational conditions and pipe geometry (i.e., diameter and thickness etc.). Among them, the external loads which mainly come from a live loading increase rapidly due to the growth of traffic. With the higher growth of traffic, the existing capacities of roads have exceeded and hence required widening. Further, when the roads are widening, the existing shoulders automatically turn to lanes, causing the existing cover depths of pipes are inadequate to cater new loading. Due to this reason, the highway authorities now have persuaded to shift the utility lines under the shoulder /foot walk when widening or reconstructing of any road and the highway authorities allocated significant amount from rehabilitation budget for utility shifting. Hence it is essential to establish criteria to decide the safe cover depths for utility lines. This research is an attempt to develop a criterion to find the safe depth of cover for locating underground water lines based on various Traffic loading conditions.

As a first step, the stresses acting on pipes under specified depths were found by using “CIRCLY” mechanistic pavement design software. The different pavement layer properties (i.e. thickness, elastic modulus, poisson ratio) and Design Equivalent standard axles (DESA) were given as inputs. Then the stresses were obtained for different depths and DESA values.

The second step was the modelling of the pipe using “Solid Works” software. Polyethylene (PE) type pipe (diameter of 110 mm) was used for modelling as it is widely used for water distribution in urban areas. The stresses were given separately for the analysis of the pipe. Then

the fatigue analysis was done in order to obtain the number of cycles to fail the pipe in each depth and in each DESA.

Finally, a graph was developed which ease in finding the safe depth of locating pipes for various design traffic loadings.

Key words: Pipelines, Fatigue analysis, Safe depth

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Time Available for Compaction of Asphalt Concrete (TAC) in Tropical Countries

A. M. K. Nishantha¹, W. K. Mampearachchi²

Abstract

Road sector development is increased rapidly in Sri Lanka after the civil war. Asphalt concrete is most widely used for the construction of roads due to fast construction, durability, and comfortability, construction easiness compared to other materials.

The aim of this research is to identify the time available for compaction of hot mixed asphalt concrete in the field, during both day time and night time. The temperature of the asphalt mixture directly affects for compaction process. In this study, measure the time available for cooling of laid asphalt up to 90°C for ABC base and existing asphalt roads. The parameters taken are asphalt layer thickness, base temperature, ambient temperature with different mixtures and different types of asphalt pavers.

The standard specification for construction and maintenance of roads and bridges (ICTAD) has specified that the breakdown and the intermediate rolling shall be carried out at a temperature not less than 135°C and 115°C respectively. The final rolling shall be completed before the temperature of the mix falls below 90°C.

In the field, thermocouples were installed in different layer thicknesses of asphalt to measure temperature changes and recorded at five-minute intervals of the same mixture throughout the day. Measurements were taken in different types of mixtures and observed the available time for compaction of HMA. It was found that the cooling rate of HMA is significantly affected the measured parameters and best results were found from 12.30 pm to 1.30pm and also found that lay down temperature below 135°C was not significantly affected to compaction of HMA and need to complete all the compaction process before 900C.

In this research found that cooling rate of HMA mixes are significantly affected environmental factors and layer thicknesses of the mixes and also found that first 10 -15 minutes cooling rate is greater. Also found that the binder course cooling rate is greater than wearing course.

Key words: Temperature of asphalt, HMA, Aggregate base course, TAC, Asphalt compaction

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3. Poster Session

Investigation of Distresses of Block Paved Roads and Condition Evaluation

T. M. A. D. Samaraweera¹, H. R. Pasindu²

Abstract

Sri Lankan road network is consisting with a high number of rural roads and the Governments over the past decade or so have invested a substantial amount on rural road upgrading and expansion. A large portion of them was allocated to improve rural roads with interlocking block paving, for example in 2013 and 2014 the government allocated about Rs. 7 bn for interlocking paving roads.

As we have a large number of concrete block paved roads which are older than five years, this is a suitable time for reassessing the performance of block paved roads. The study aims to identify common distresses in block paved road surfaces, evaluate the pavement condition using interlocking concrete pavement distress manual, find out the applicability of the pavement condition index method to Sri Lankan paved roads and identify improvements to extend the service life of road surfaces.

Selected road sections with interlocking block paving in Gampaha District was evaluated to as a sample. The common distresses of the block paved roads observed were damaged pavers, depressions and edge restraint. The methodology proposed in the Interlocking Concrete Block Pavement Distress Guide was applied to evaluate the condition of the road sections. The results suggest that Concrete block paving is a durable road paving method with more than five years of service life, the cause for most distresses is poor drainage and 'Distress Manual' is a reliable method for evaluation of block paved roads in Sri Lanka.

The result of this study would be useful for comparing the performance concrete block paving method with other pavement techniques and to identify remedial measures to in the construction method to mitigate the observed issues It further assesses the applicability of the PCI method as quality to assess the performance of block paved roads for maintenance.

Key words: Interlocking concrete blocks, Rural roads, Pavement condition index

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The Study on Saturation Flow at Signalized Intersection

P. D. R. Perera¹, J. M. S.J. Bandara²

Abstract

Signalized intersections are an essential part of a road network in urban areas where the traffic congestion has been a major problem. In the design of signalized intersections, capacity is the key factor and the saturation flow rate plays an important role in determining the capacity. Therefore, saturation flow can be considered as an important parameter which is used for the planning, designing and controlling a signalized intersection. Accurate saturation flow values are a fundamental criterion in the management of efficient and effective traffic signal control and intersection design. Many countries had executed researches regarding the saturation flow rates to suit their traffic conditions and identified the major factors which affect the saturation flow which might be not suited for our local traffic conditions. Therefore, the objective of this study was to collect a large sample of field measurements and identify the way of pattern of varying the saturation flow with the different factors which directly affected.

Sri Lanka is a developing country and cities are undergoing rapid urbanization. As a result, there is rapid growth in the road traffic. Traffic movement is very complex due to the heterogeneous traffic stream sharing the same carriageway. With this study, it can be identified that this heterogeneous traffic condition is one of the major factors which affect the variation of the saturation flow. A large number of motorcycles and three-wheelers can be seen at the signalized intersections and they increase the capacity and heavy vehicles reduce the capacity as well. By considering all those facts it should be corrected the saturation flow rates which are using for the traffic signal timing calculations as suit for the traffic conditions.

Keywords: Signalized intersection, Saturation flow, Capacity, Mixed traffic

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TRAZER Video Image Processing Software as a Tool for Heterogeneous Traffic Data Collection

D. N. D. Jayaratne¹, H. R. Pasindu²

Abstract

Empirical traffic data is the basic input of any traffic related venture be its traffic management, transport planning, or research in the field of traffic engineering. According to its application different types of traffic data are required. The fundamental types of macroscopic traffic data are speed (km/h), flow (veh/h), and density (veh/km). Microscopic traffic data include dynamics of individual vehicles and how they interact with neighbouring vehicles and the road geometry in a traffic stream. Various traffic data collection methods are available for these purposes. Manual traffic data collection is the primary and oldest method used for data collection. But this method is neither cost effective nor consistently accurate. To overcome these issues alternate traffic data collection technologies such as pneumatic road tubes, Induction loops, Videography, Infrared detection were developed.

Videography as a method for data collection is popular because the traffic condition can be visually observed later on. But extraction and analysis of traffic data from a video is a tedious process. Hence software programs such as TRAIS, COUNTcam, TrafficVision, TRAZER, MediaTD, Picomixer STA etc. have been developed.

In this research, the software program TRAZER is used for traffic data collection, and its performance as a traffic data collection tool is analysed. The version of the TRAZER software used for this research provides the user with the facility to detect 4 main vehicle categories; namely, Light moving vehicles (LMV), Heavy moving vehicles (HMV), Three Wheelers (3W) and Two wheelers (2W). HMV's are further classified as Buses (BUS) and Trucks (TRUCK).

Two 1-hour videos were recorded according to the specifications for analysis in this research. One at Pannipitiya (video 1) overlooking the A4 highway from an overhead foot bridge and one at the Colombo-Katunayake (video 2) Expressway overlooking the expressway from an overpass near Peliyagoda.

The software offers options to delete, reclassify and add vehicles to its output thereby giving the user the ability to rectify software errors and raise the accuracy of the count to 100%.

Video 1's initial vehicle count was 62.3% greater than the actual value. (4503 as opposed to the actual flow of 2774 vehicles) This was mainly due to phantom detection of motor cycles. The primary reason for this being the recognition of vehicle side mirrors as motor cycles. Once the incorrectly detected vehicles were deleted the flow value reduced to 2073, which is 25.3% less than the actual value. This was rectified by adding the overlooked vehicles manually. Video 2's output was more accurate. The main reason for this is the absence of motor cycles and three wheelers in the expressway. The initial flow value was 1104 vehicles. Once accidental recognitions were removed, the value reduced to 953 which was 23.9% less than the actual value of 1252 vehicles.

From this, it can be seen that the software provides vehicle counts to an accuracy of approximately 75% once accidental recognitions are removed. An advantage of using the software is that the accuracy can be raised to 100% manually. But a significant amount of time must be spent to identify the vehicles that are not captured by the software. TRAZER also gives individual speeds and trajectories of each vehicle. The speed estimations were checked by manually calculating the speed of selected vehicles from each category by observing the recorded video. The estimated speeds were found to be similar to the values derived manually.

From this research, it can be concluded that TRAZER is an acceptable tool to collect and analyse traffic data even though conclusive results were not observed in the initial runs. This may partly be due to user errors in handling the software and capturing the video or issues unique to the analysed videos. Further studies should be done to analyse the speeds more accurately as well the vehicle trajectories.

Keywords: TRAZER, Video Image Processing, Traffic Data, Data Collection

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Development of a Methodology for Optimization and Prioritization of Pavement Maintenance for Provincial Road Networks

H D S Gunasomma¹, H.R. Pasindu²

Abstract

Pavement management system is a decision support system that is used by road development agencies to maintain its road networks, extending their useful life within the available budget and resource constraints. The methodology of selecting maintenance strategies for authorities is an integral component of the pavement management system. Most current systems cannot be customized to reflect the local conditions with resources available and required extensive data collection and calibration, which are not sustainable for those authorities, especially in developing countries. Thus, the identification of new approaches, which have been addresses the issues in implementing a pavement management system in developing countries such as Sri Lanka, is a major requirement.

This paper proposes a methodology adopting optimization and prioritization models to be used by local provincial road agencies, which assist the decision making for selecting roads for pavement maintenance.

The study is focused on the existing pavement management systems, their components, institutional characteristics and their methodology to identify the main constraints that affect the pavement maintenance planning and for the formulation of the maintenance strategy in the provincial road agencies. Main constraints and priority factors were identified by the opinion survey from the Engineers of provincial road agencies. Based on the opinion survey five main priority factors were finalized namely Pavement condition, traffic volume, Connections to existing roads, Land use pattern and Importance to the community. The optimization model was developed to maximize the network performance while considering the budget constraints. The Priority index that is computed for different roads is incorporated into the optimization model. The proposed procedure presents an integrated prioritization and optimization approach applying Analytical Hierarchy Process (AHP) and linear programming.

Keywords: Optimization, Prioritization, Pavement Management

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Suggestions to Improve Solutions Discussed in Western Region Megapolis Planning Project for Traffic Congestion

S. A. I. A. Suraweera¹, Ishani Dias²

Abstract

Urbanization can be recognized as one of the major concerns when considering sustainable development of Sri Lanka after the end of civil war. Some of the issues that take place due to urbanization are a commuter rush, over concentration of the population, traffic congestion, environmental issues and rapid spread of diseases etc. This paper focuses on one major civil engineering related issue, which can be identified as the traffic congestion in urban areas. However, Sri Lankan government has already introduced an urban development project for the Western province called Western region mega polis master planning project (WRMPP), but many inconsistencies can be identified regarding the solutions introduced in WRMPP for traffic congestion. Therefore, the main objective of this paper is to identify inconsistencies in the WRMPP regarding traffic congestion and to suggest solutions and innovative concepts to develop the strategies discussed in WRMPP. The concepts discussed in the paper are influenced by urban development methods used in developed countries such as UK, USA, Singapore and mainly in Japan. In addition, this paper focuses mainly on suggesting new methods to reduce traffic congestion in intersections, to introduce advanced technologies used in developed countries for public transportation, which results in a reduction of traffic congestion and to propose ideas to design new roads (bypasses) as alternative routes for people to travel, in order to travel without interference of traffic congestions urban areas. Smart traffic control system, Maglev technology trains and Bypass roads are suggested as main solutions, which will be further discussed in this paper, as results of carrying out this research. However, it is clear that the current urban development trends in Sri Lanka paved the way towards many complex issues, therefore it is essential to introduce new urban development policies and strategies for the future development of the country.

Keywords: Western region megapolis master plan, Smart traffic lights, Maglev technology trains, Bypass roads, Congestion, Sri Lanka

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