TRANSPORT RESEARCH FORUM 2012

Abstracts

20th July 2012
Colombo, Sri Lanka

**Transportation Engineering Division
Department of Civil Engineering
University of Moratuwa**

Conference Program
Transport Research Forum 2012

Plenary Session	9.00 am – 10.30 am

Technical Session 1	11.00 am – 12.30 pm

H1: Highway Engineering

- A Review of Penetration Grading System and the Suitability of Alternate Grading System for Asphalt Binders in Sri Lanka Highways
- Evaluation of Feasibility of Polymer Modified Asphalt Binders for Sri Lankan Conditions
- Comparison of Density Specifications Used for Construction of Hot Mix Asphalt (HMA)
- Investigation on, Suitability of Cohessionless soil as a highway construction material

T1: Traffic Engineering & Planning

- Dynamic Travel Time Estimation Model for Real Time Travelers
- Evaluation of Flood Risk of Transport Infrastructure Using GIS Technology
- An Examination of the Appropriateness of Flyovers as a Traffic Management Measure to the Road Intersections of Sri Lanka
- Effectiveness of Vehicle-Actuated Signals for at Grade Four Legged Intersections in Sri Lanka: A Comparison Study Against Existing Fixed-Time Traffic Signals

Technical Session 2	1.30 pm – 3.00 pm

H2: Highway Planning

- Review of Axle Load Limits on Provincial Roads
- Finding Thresholds Based on Traffic, Sub-grade and Climate for Upgrading Surface Type of Roads Using HDM-4 Model
- An Approach to Evaluate Horizontal Alignment of Highways Using Curvature Index and Operating Vehicle Speed
- Selection Criteria for Minor Road Crossings for Expressways

T2: Public Transportation & Road Safety

- Study on Promotion of Bicycles for School Children in Eastern Province
- Development of Transport Infrastructure Master Plan for Long Distance Travel
- Franchising of Long Distance Bus Service in Sri Lanka in Order to Improve the Quality of the Service
- Compensation Systems for Road Accident Victims

Technical Session 3	3.30 pm – 5.00 pm

H3: Highway Construction & Maintenance

- Evaluation of Cost Effectiveness of Performance Based Maintenance Contract
- Effectiveness of Rolling Straight Edge for Quality Control of Asphalt Concrete Surfacing
- The Cement Stabilized Soil as a Road Base Material for Sri Lankan Roads
- Cost Overruns of Foreign Funded Highway Projects in Sri Lanka

T3: Traffic & Transport Planning

- Comparison of Transport-Land Use Models
- GIS Based Classification System for Low Volume Roads
- Improvements Need in Evaluation of Road Rehabilitation Projects
- Evaluation of Parameters Influencing Delays for Road Users at Railway Level Crossings in Sri Lanka

Transport Research Forum 2012

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Parallel Session H3: Traffic Engineering

Parallel Session T3: Society & Environment

Challenges of Wearing Course Mix Design for Hambanthota International Airport

J.N.Meegahage[1] and W.K.Mampearachchi[2]

Hambanthota international Airport (HIA) is a major ongoing development project in Sri Lanka. Since an Airport is a very important location for a country, durability and long term performance with least maintenance is fully ensured in the selection of material to the design and the construction methods in airport runways. In HIA, wearing course of runway has been decided to construct using Polymer Modified Bitumen (PMB) which is currently unfamiliar to Sri Lankan Highway industry. The modified binder to be used in the construction is PG 76-22 SBS modified binder. Further more the specified aggregate gradation for the design is coarser than the ones currently using in Sri Lankan highway industry. So it's a challenging task to prepare a mix design for the wearing course.

Polymer modified binder properties are different from conventional bitumen with high resistance to deformation at elevated temperatures and cracking at low temperatures. Some additional tests are included for the SBS modified binder to ensure its quality such as elastic recovery test and separation tendency test which are currently unfamiliar. Establishment of Viscosity ranges of the modified binder for compaction and mixing temperatures was a challenging task since the polymer modified binder behavior is non Newtonian..

In HIA the aggregate gradation selected for the mix design is coarse than the normally used aggregate gradation for asphalt wearing course. The maximum aggregate size is 31.5mm and the minimum size is 0.063mm. The aggregate was blended to avoid the maximum density line of Thompson and fuller curve and the Superpave restricted area to meet the design criteria.

The mix design for asphalt concrete was done using the marshal mix design. The asphalt mixing and compactions were conducted at different temperatures to obtain the optimum temperature for mixing and compactions. The gradation has considerable effect on satisfying the specification limits of air voids (VTM) and void in mineral aggregate (VMA). Effect of gradation, mixing and compaction temperatures were studied in the mix design using PMB binders.

Keywords: Asphalt Mix Design, Wearing Course, Polymer Modified Binder

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Mechanistic Empirical Method of Pavement Design

R.M.T.M.Dahigamuwa[1], D.L.Marasinghe[2] W.D.N.G.Wanniarachchi[3] and Dr.

W.K.Mampearachchi[4]

The objective of this research is to analyze the reason for the failure of A15 Trinco-Batticaloa rehabilitated road with the help of mechanistic tool, KENLAYER.

With the appearance of pot holes and cracks the attention was moved to this road section. Empirical methods failed to identify the reason behind this failure and therefore mechanistic tools such as KENLAYER became more useful of analyzing it.

Mechanistic approach to pavement design seeks to explain phenomena only by reference to physical causes. Thus it uses stresses, strains and deflections within a pavement structure to analyze the loads and material properties of the pavement. It is planned to obtain different deflections, stresses and strains for different axle loads and different sub grade and sub base CBR values.

For the analysis two type of data is required. These are CBR data obtained from the soil and the traffic data of the road section along with the material it carries. Axle load survey would be a better option but due to its expensiveness traffic load survey was selected. CBR data would be collected through DCP tests carried on site and laboratory CBR tests.

This study would prevent future failures of road pavements like this and would be a great use for future highway design Engineers. Through this study, the use of KENLAYER software would improve among highway Engineers in Sri Lanka and this would be a great advancement in the highway industry of the country.

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Effective DGAB Construction Techniques for Optimizing Segregation during Compaction Process

K. V. R. K. Ariyarathne[1] and W.K.Mampearachchi[2]

Road construction in Sri Lanka widely uses Graded Aggregate (Dense Graded Aggregate Base - DGAB) for base construction with RDA specified Gradation requirements. But in loading, transporting, unloading, handling and in construction processes the segregation occurs deviating specified gradation.

This study covered investigation on DGAB segregation during layer compaction by focusing;

(1) What factors contribute to segregation of DGAB Layers, (2) The relationship between compaction effort and segregation, (3)The co-relations between water content, compaction effort and the extent of segregation , (4) To find out practical measures to control / minimize segregation effect in layer compaction

In site trials it is generally observed that following segregation effects present and those make compacted layer non-uniform throughout its depth, (1) Fine particles tend to migrate upward while course particles remain at underneath layers at high water content. And (2) Fine Particles tend to settle down at dry condition

Compaction trials were done in both thin (App. 150mm Loose) and thick layers (App. 225mm Loose). A number of factors like layer thickness, water content at compaction, the type of roller used (weight, with or without vibration) gives a major impact on particle dislocation and to the extent of segregation.

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Development of a Methodology to Identify the Critical Locations and Suitable Roads to Conduct Road Safety Audit

P. M. Warnakulasuriya[1] and J.M.S.J. Bandara[2]

Road Safety Audit (RSA) can be conducted on new road projects, road improvement projects and existing roads. It is a formal process using a defined procedure and it should be performed by a group of auditors with appropriate experience and training. The audit process provides, at regular intervals, for independent safety assessments and recommendations.

Road Safety Audits assess the operation of a road, focusing on road safety for all road users, including pedestrians (along with children, elderly and disabled) and cyclists. The outcome of road safety audit is an Audit/Survey Report, which identifies potential or existing road safety deficiencies and makes recommendations aimed at removing or reducing those deficiencies.

There are several Guidelines & checklists for Road Safety Audits developed by organizations such as U. S. Department of Transportation, Asian Development Bank (ADB), National Roads Authority Ireland and other developed countries. Guidelines for Road Safety Audit have developed for the Road Development Authority (RDA) to be used for RDA roads as well as for other organizations responsible for their roads in Sri Lanka by SweRoad in association with RDC, as a part of the consultancy services in the Road Safety Component (RSC) of the Southern Transport Development Project (STDP) in 2005.

There are 12,020 km of Class A & B roads in Sri Lankan road network under the responsibility of the Road Development Authority (RDA). Out of that, about 4,500 km length have recently improved or rehabilitated. In addition, there are over 75,000 kms of other roads under the responsibility of Provincial RDA (PRDA) or other Local Government Authorities.

To conduct a RSA as per the guidelines developed for Sri Lankan roads, the relevant Road Authority shall give this task to a group of auditors with appropriate experience and training. Also at some locations, the occurrence of an accident depends on the time of the day and also depends on the day of the week. To conduct RSA by a group of auditors with appropriate experience and training for all these roads on regular basis are very difficult and expensive.

Therefore, the Purpose of this study is to develop a simplified methodology to identify the critical locations to be selected for RSA and also to identify the critical time & day to conduct such RSA. This study is limited only for the existing roads in Sri Lanka. It is intend to develop simplified formats to collect data for different types of road sections & intersections by different observers. It is also intend to develop a points system to identify the critical road sections & intersections using the collected data by the different observers in order to conduct detail RSA by group of auditors with appropriate experience and training. Using the points system the relevant Road Authority can prioritize the RSA schedule for their roads and can identify the most critical roads, road sections or intersections for next RSA.

The following methodology was used for this study:

1. Review of RSA guidelines & check lists developed for Sri Lanka & for other countries and any other related literature on road safety;

2. Interview experts who are dealing with road safety aspects.

3. Development of simplified formats to collect data for different types of road sections & intersections. One simplified method of data capturing is by reviewing the data collected by the Multi-Function Network Survey Vehicle (MFNSV).

4. Development of a points system to identify a priority order for the critical roads, sections & intersections to conduct RSA.

5. Conduct trial surveys to verify the developed methodology.

6. Improve the methodology & data collecting formats based on the results of the trial surveys.

7. Present the developed a methodology to identify the critical roads, sections & intersections to be selected for RSA and also to identify the critical time & day to conduct such RSA.

Keywords: Road Safety Audit, RSA

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Optimization of the Current Design Practice for Differently Able Road Facilities in Sri Lanka-Case Study

L.D.U.N. Liyanage[1] and W.K. Mampearachchi[2]

We all have a social obligation to respect the rights of our fellow human beings. Even if some people may lack certain abilities we all share same needs and expectations. People having disabilities have to spend the entire life struggling with their physique itself and might not have the freedom to stand for their own rights. Thus as people with fewer difficulties we have duty to stand beside them and support them.

Accessibility protects the basic rights of a human being such as the right to receive facilities like healthcare, education and the right to do an occupation to earn one's live etc. Therefore, it is essential to develop a barrier free road environment that guarantees accessibility for all.

Disabled accessibility is not a new concept to the world. There are many related codes and practices in other countries. Sri Lanka has recently introduced this concept to the road infrastructure by improving the Bambalapitiya – Kollupitiya road section as disabled friendly by following guidelines given in **the Gazette of Democratic Socialist Republic of Sri Lanka (No 1,467/15-17/10/2006).**

In this case study the newly introduced road facility was checked for its suitability for the country considering social and economic aspects. It was checked whether the design fulfils the intended purpose. Two visually impaired people participated in this study. They were asked to walk along the tactile guide way so that their behavior can be observed. Comments were taken from them regarding their personal experience and ideas for further improvement. In order to make decisions, further knowledge was gained through several sources such as the educational video "Pathway to independence" a product of "Nebraska Commission for the Blind and Visually Impaired" and also from documents such as **RTS 14 Guidelines, ESCWA design manual,** TRL Overseas Road Note 21.

Several problems were identified from the study of new facility. Most importantly when compared with guidelines which have been followed, there were deviations of construction due to faulty workmanship. It was obvious that the guidelines have been prepared neither with proper understanding of differently abled people nor the suitability of the design for our country. After considering all these facts, the author was able to modify some guidelines and even come up with new ones. New layouts were introduced to the pedestrian walkway.

Keywords: Accessibility – Differently abled

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Simplified Guideline for Road Markings and Placement of Road Signs

A.A. Prematilake[1] and J.M.S.J. Bandara[2]

Ministry of Prots & Highways and the Road Development Authority (RDA) have been focusing attention to introduce a Revised manual for Traffic Signs and Markings which is in conformity with the stipulations given in the Vienna Convention. As a result, Revised Regulations are in the threshold of publishing as an Act passed in the Parliament in near future. This will replace the Regulations which are currently in use.

A Manual on Traffic Control Devices has already been prepared for the use after the Revised Act come into effect. This manual itself says that the traffic sign and road marking numbering system developed for this manual is entirely different to the numbering system which is currently in practice. Therefore, it can be expected that some difficulties may arise when this new system is implemented. In some selected newly rehabilitated roads, new Traffic control signs and markings have been used by RDA on trial basis.

Current practice for marking road centerlines and placing of danger warning signs is based on the Regulations of Gazette Notification No.444/18 published on 13th March 1987. No simplified guideline has been developed so far to use with these regulations. As a result, marked centerlines and fixed warning signs in roads show remarkable deficiencies in practice. When examining different roads, it is clear that methods practiced are highly subjective. Changing marked centerlines on roads time to time to do trials can be commonly seen.

The paper present an attempt to prepare simplified guidelines to mark road centerlines and placing of danger warning signs based on the proposed revised Act which is in the threshold of publishing. " The Manual on Traffic Control Devices" would fill the gap between the proposed revised Act and the knowledge of practitioners to some extent. But, when examining the roads used for try out the new method, it is clear that still there are some practical deficiencies. The reason may be the fact that the manual discussed only the individual situations. In combined situation this manual does not give sufficient guidance. As examples, the manual discuss about single horizontal curve and single vertical curve individually. But it does not give any guidance on reverse curves and combination of horizontal and vertical curves. This paper address this type of complex situations in depth and proposes to have a simplified methods to practice. This is done by carefully studying existing conflicts and shortcomings in the current practice and in the newly proposed method and by proposing ways and means to overcome these identified shortcomings using experience of current method

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Study the Variation of Visibility of Road Marking with Time due to Traffic in Urban National Roads in Sri Lanka

Sumendra M.A.P[1], Bandara J. M. S. J[2]

It has long been recognized that visibility of road marking is essential for efficient traffic flow and road safety. There are complaints of that the road marking in many national road of Sri Lanka have poor visibility in daytime and nighttime. The major reason for the poor visibility is low reflection levels of road markings. The performance of the road marking is affected due to embedment of glass beads, water on road way, drivers eyesight ,position and quality of headlamps, road surface debris etc. Retro-reflectivity is the ability of a road marking to reflect light from a vehicles head lights to the driving position of a vehicle. It will be determined by the amount of glass beads spread on the line and amount and quality of glass beads included in the body of road marking.

Main objective of this research is to understand the variation of visibility of road marking with time due to traffic and other environmental parameters, identify the optimum frequency of time for remarking in urban roads and introduce a guide line for remarking of road marking while integrating as a program to a road database in highway management tool as a future implementation.

Preliminary measurement carried at some high volume traffic roads in western province that considerable amount of reduction of reflectivity with time due to traffic. For example Galle road (A002) that has ADT of 77450 the reflectivity has changed by 46% after 9 months. Base line road (M001) has ADT of 90645 the reflectivity has changed by 62% after 6 months. Kollupitiya -Sri Jayawardanapura road (A000) has ADT of 79490 the reflectivity has changed by 69% after 12 months. The rate of reduction of reflectivity (RL per day) for Galle road (A002), Base line road (M001) and Sri Jayawardanapura road (A000) are 0.24, 0.48 and 0.26 per day respectively. IS EN 1436 and SLS 1384 introduces specifying   criteria for yellow and white road markings .In IS EN 1436 the retro reflectivity value is given as 100mcd/m^2 / lux for dry white road markings and in SLS 1384 this value is given as 70mcd/m^2 / lux. A relationship between the reduction of reflectivity and traffic and road environment parameters to be developed based on the reflectivity measurements.

Keywords: Retro Reflectivity, Daytime Visibility, Nighttime Visibility, ADT

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Development of Polymer Modified Bitumen Specification for Sri Lanka

H.S. Sitinamaluwa[1] and W.K. Mampearachchi[2]

Implementation of polymer modified bitumen (PMB) is a new movement of Sri Lankan highway industry and it has become a challenging task for many reasons. One is, currently used penetration grading system is inadequate for proper quality control of PMB. The improper use of PMB would result in poor pavement performance and will lead to serious maintenance and cost issues. And the lack of experience of Sri Lankan engineers is a problem since a very strict process control is required. Hence there is the need of a proper guideline to implement PMB in Sri Lanka.

The Performance Grading system is considered as the most effective specification for bitumen since the test methods capture fundamental rheological properties of bitumen. This was successfully implemented in USA; but is lagging in other parts of the world due to the cost and complexity of the new test equipment. But the empirical tests also are taken as indirectly related to the road performance for centuries. In PMB specifications of countries such as Australia, UK, India, Brazil, China etc. it is evident that the used test methods does not necessarily measure fundamental rheological properties of bitumen, but the empirical tests which are indirectly related to the characteristics of bitumen.

In this research, the possibility of developing a Sri Lankan Specification of PMB with available test methods was studied. The important bitumen properties that are necessarily needed to be controlled are identified and the test methods which can determine those characteristics are included in the specification. Requirement limits for each test are set according to literature findings. Here the controlling of mixing and compaction temperatures for PMB was specially considered since it is a major practical issue. Further development for this specification can carry out with the experience of SL engineers in future, and the developed specification would be a great assistance for earlier stages of PMB pavements in Sri Lanka.

Keywords: Polymer modified bitumen-specification

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Property Change of Road Metal with Blasting Effects

Abeysinghe, A.L.N.U. [1] and Mampearachchi, W.K. [2]

Road metal is the largest component which contributes for road construction. Normally, in Sri Lanka naturally occurred sources are not available to suite the construction work. So, most commonly this requirement is fulfilled by excavating of rocks and crushing to the suitable sizes.

With the current development of the highway sector in Sri lanka, the demand for the road metal is gone up and it is very difficult to full fill the requirement. In some areas in the country especially in the Northern area it is hard to full fill these requirements due to several reasons like archeological areas, environmental sensitive forest areas etc.

So, the quality control and fulfillment of the requirement with the available limited sources is very important.

When consider the use of crushed rock for the road construction, it is important to select materials in an acceptable quality. To ensure the quality, various tests have been introduced by relevant authorities. Especially when crushed rock use for the road bases and surfacing these properties are very much important to ensure the durability. When selecting a source to produce crushed rock as road construction material, production from the selected source have to be satisfied certain requirements. The LOS ANGELES ABRASION VALUE (LAAV) and AGGREGATE IMPACT VALUE (AIV) are the two important tests to be carried out to ensure the strength requirement of the road metal.

 It has been noted that with the blasting operation, there is a considerable variation of rock fragmentation and it is mainly due to the quantity of explosive that use for the blasting operation. Types and features of explosives and blasting design also play an important role of rock mass fragmentation.

In Sri Lanka, blasting design patterns and explosives that are using is not varying considerably. But usage of explosives changes in continuous operation even the place is unchanged. Sometimes these changes are due to environmental condition such as rainy seasons and due to some significant change of nature and properties of rock mass.

The objective of this study is identify the changes of AIV and LAAV with the use of explosive percentage use for the blasting operation and improve the strength of road metal by controlling the explosive usage for the metal production. Ensure the quality control of material production with less variation of strength, due to blasting operation.

Keywords: Los Angeles Abrasion Value, Aggregate Impact Value, Explosive Percentage

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Relationships between C.B.R and D.C.P Testing for Different Soil Types

W.M.I.S.K. Wijekoon[1] and Dr. W. K. Mampearachchi.[2]

When planning and design a highway. Assessment of sub grade shear strength is very important General practice adapts to measure the sub grade strength is called California Bearing Ratio (CBR). Standard CBR laboratory method testing requires sampling transport of soil to laboratory and then takes at least four day period for necessary testing procedures. Field CBR method is also time consuming method. Due to these reasons Dynamic Cone Panetrometer (DCP) is used and then correlated the DCP reading to a C.B.R value for design evaluation

The significant advantages of the DCP are that it is a low cost, robust apparatus that is quick and simple to use. Very little damage is done to the pavement being tested (effectively nondestructive) and very useful information is obtained. One of the major advantages of the test is that the pavement is tested in the condition at which it performs. The simplicity of the test allows repeated testing to minimize errors and also to account for temporal effects. It should be noted that there are inherent inaccuracies in most CBR test results and these coupled with the material dependency of the DCP results make the DCP interpretation a very good indicator, but it should never be used as an absolute indicator of the in situ CBR strength of a material in a pavement. However following factor will effect to change both field D.C.P and C.B.R; (1) Field Moisture content (2) Plasticity Index (3) Instrumental and other man made errors and (4) Field Density

These studies show that how far this DCP CBR relationship is viable .DCP had the most consistent results within the different layers. If there is any possibility to make good correlations between the DCP with the CBR. what are the other factors to be considered when preparing relationships between D.C.P and C.B.R.

 However, the results of this study indicated that the DCP can give more reliable result to the field CBR values, when PI is less than 10. When PI increases it is very difficult to predict because soil characteristics drastically change with soil properties. Therefore, some detail soil investigation is necessary even to predict the design CBR at the particular locations.

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Use of GIS to Identify Alternative Traces for Railway Planning & Development

Kelum Wickramarathne[1] and Saman Bandara[2]

The railway transportation is a one of the energy efficient transportation mode all around the world, as its capability of loading & transporting large amount of passengers and goods economically & safely. In the British colonial era, the railway transportation has been introduced in Sri Lanka, to transport the productions of plantations such as coffee, coco, tea, rubber, coconut, spices & etc, to the port, from up country and all around the island. With the development of new and faster roads forming in to a well connected network and introduction of efficient cars, buses and trucks, railway modal share has decreased. Today there is a need to introduced new railway lines that are faster and also forming a well connected network.

Physically, the speed of a train, depend on curvature & gradient of the track. Hence it is important to identify traces that satisfy speed requirements to compete with road traffic. When developing new rail line or roads it is mandatory to consider reasonable alternatives prior to selecting the final trace. With the limited amount of maps and other resources available one cannot spend lot of time to identify possible alternatives using land and field surveys, maps & other primary surveying equipments, when the railway planning & construction phase in Sri Lanka in the past.

The paper present an attempt made to use GIS tools such as Spatial Analysis, 3D Analysis, etc to identify possible alternative traces for detail studies using minimum map data available along with available satellite images.

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Optimizing Passenger and Baggage Flow in an Airport Terminal

Shamain Saparamadu[1] and Saman Bandara[2]

Air travel is very important mode of transport, especially for long distance travel. It opens up greater horizons for exploration for many people, permitting modern citizens to become significantly well-traveled than their predecessors. But considering air travels, passengers sometimes have to move through complicated airline terminals and negotiate crowded hallways during peak hours. They must drag along heavy baggage and perhaps travel up and down stairs to reach their gate or board their plane. They must reach their desired gate by a certain deadline or miss their flight, resulting in a loss of time and money. This situation is very complicated because it is compounded by connecting flights, travelers must reach another gate in an airport in a shorter time frame and also an airport is totally unfamiliar to them.

According to airport records, in Sri Lankan airports passengers must spend around 3 hours at the terminals and also spend around 1- 1 ½ hours at the boarding gate. Normally they walk around 800m from the entrance to the plane and they walk around 400m with baggage. Minimizing time spent and distance walk through airport terminal will help improving the capacity while providing a level of service to the users.

There is a need to study and understand overall flow movement of passengers and baggage through airport terminals. Many attempts have been made to model airport operations, passenger/baggage flow through specific terminal facility such as ticket counters, immigration etc. and or model specific terminal configuration situation.

This paper presents an overview of exiting literature on passenger or baggage flow in airport terminal and proposes a methodology to develop a mathematical model to study the overall passenger/baggage flow through an airport terminal.

Keywords: terminal configuration, mathematical model

Authors Details;

Strategy to Identify Optimum Travel Routes for Improvements in an Urban Area

R P G K S Rajapaksha[1], Loshaka Perera[2] and J M S J Bandara[3]

Transportation is a basic requirement in any city in the world for its economic, social and other developments. Different cities in the world use various means of transportation to achieve their goals and objectives. In general, minimum travel time, comfort and safety can be considered as primary objectives of any cities transport plan. In urban cities, it's a well-known fact that transport planning is imperative to achieve its day to day and long term goals. Congestion is very commonly seen condition in most of the urban areas in the world and there is no exception for Sri Lanka as well.

In an urban context, users may have various origins and destinations in their travel needs varying over the time. These needs may have primarily arisen due to the land use mix or social desires. However, it is transport planners duty to full fill these transportation needs of users effectively under given circumstances. In that aspect identification of high demanding origins and destinations are very important and recognizing minimum distance or minimum travel time routes are critical. Proper information or planning system would direct users effectively and could able to cut off unnecessary congestion significantly. Thus, this study will explain a strategy to identify travel routes in urban area with respect to time and distance variables, where improvements can be done to reduce congestion effectively.

Identification of prominent OD pairs, traffic flow conditions and capacities at different corridors, travel distances between OD's, travel time between OD's and most preferred routes by users can be considered as main inputs in this nature of study.

Colombo city was selected as a case study and Origin-Destination (OD) surveys were carried out at number of selected locations along with traffic flow counts, taken at main and sub corridors connecting to Colombo city. Based on the OD survey analysis, prominent origins and destinations were recognized and travel time between each and every combination of origin and destination were measured multiple times, in peak and off peak conditions. Based on the collected data minimum travel time between OD's and minimum travel time route were identified.

Using the Arc GIS software, a road network plan was developed and minimum distance routes were identified between OD's. Further, there are instances where users use completely or slightly different routes to reach their destinations other than mentioned above and thus those routes were also recognized as commonly used routes to see what deviates from the minimum distance or minimum time path.

Comparison of three different routes obtained from the study revealed many problems and counter measures were given to improve the efficiency of existing conditions cost effectively.

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The Estimation of Saturation Flow and Passenger Car Units (PCU) at Traffic Signals for Sri Lankan Conditions

U.K.M.K. Kularathna[1] and J.M.S.J. Bandara[2]

Saturation flow rate is the equivalent hourly flow rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced, in vehicles per hour of green or vehicles per hour of green per lane. The saturation flow on an approach to a traffic signal are very important inputs to methods of estimating delay-minimizing or capacity maximizing signal settings. Procedures for signalized intersection analysis often recommend the use of measured saturation flow rates. However, it is impractical to measure prevailing saturation flow rate for an existing site and it is impossible to measure saturation flow rate for a new signal installation which is yet to be constructed. Hence, the development of a saturation prediction formula based on passenger car equivalents values derived according to local traffic conditions is necessary in order to estimate saturation flow rates accurately at signalized intersections.

Passenger Car Units (PCU) are used to represent the varying effects of mixed vehicle types on saturation flows by converting a traffic stream comprising of various vehicle types into an equivalent traffic stream comprising entirely of passenger cars. It has been proved that PCU values have a significant impact on the estimation of saturation flows especially in the presence of high percentage of motorcycles & three wheelers in the traffic stream. PCU values used in Sri Lanka has not updated for a long period of time, but the traffic compositions in roads has changed significantly during recent past, therefore these PCU values are no longer accurate.

Hence, the main goal of this research is to derive the basic saturation flow values of signalized intersections which is suitable for Sri Lankan conditions. The secondary goal is to update present PCU values of the traffic stream at the signalized intersections. The data collection is being presently continued in order to obtained set of more than 2500 data in the selected traffic signals in the city of Colombo, It has now been completed only the collection of about 500 data in two traffic signalized locations.

At present Sri Lankan used saturation flow rate of 1850 pcu/hour which is derived in developed countries. According to the research, this value may differ significantly, and it is about 2000 pcu/hour at the end of analysis of about 500 data. The PCU values which are presently being used in Traffic Signal Design are derived for Multi-Lane roads by Transportation Engineering Division of University of Moratuwa. At the end of analysis of 500 data, it is shown that PCU values are slightly change to these values except that of Three wheelers. The PCU value of three wheelers has changed significantly from 0.8 to 1.3.

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Evaluation of Tires on Asphalt Pavement in Sri Lanka

Nilanka Menike

While considering Sri Lankan Road Network, it can be seen several failures especially cracking in Sri Lankan road network. The main objective of this research is to determine whether effect of tires is a reason for the failure of the roads in Sri Lanka The tire pavement contact pressure distribution is significantly affected by tire inflation pressure, tire type, tire load and tire tread pattern.

Mainly there are two types of tires use in vehicles, and these are known as Radial tires and Bias Tires. The difference is in the way the body cords are put in the tire. Bias tire has diagonal or bias plies. These plies crisscross. This makes tire strong in all directions because of the plies overlap. It causes the tire to overheat when used on a sealed road surface and therefore, wear out quickly. The tire does not contact as much ground as a radial tire, it leads to a loss of engine power transmission and greater ground damage as per literature. When considering tire thread pattern mainly two types of pattern are available. These are circumferential tread pattern [Rib] and Transverse tread pattern [Lug]. Considering the effect of tread pattern on the pavement, it has been shown that the maximum shear stresses and displacement develop under the transverse pattern tire than the circumferential thread pattern tire. Field observation of cores and trench sections extracted from asphalt concrete highway pavements in certain countries exhibited propagation of surface-initiated longitudinal wheel path cracks. The initiations for these cracks was explained by high-contact stresses induced under radial truck tires. So there are some contradictions on effect of tire on road damage. Two roads with longitudinal crack were selected for a case study in Sri Lanka with varying composition of heavy vehicles. Traffic distribution of the roads was investigated. The survey conducted among tire sellers found that bias tires are widely used in buses. It was found that radial tires are used in trucks and mostly for the rear axle which distribute significant amount of load to road surface.

Comparison of tire usage of the selected roads and type of cracking observed in roads were analyzed. Initial finding of this research indicated that the tire type, loan and amount are required for a better comparisons of the distresses appeared in the roads.

Keywords: types of tire, tread pattern, fatigue and rutting on the pavement

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Dynamic Travel Time Discoverer (DTTD) collaboration with Intelligent Transportation Systems

Udila Pilanavithana[1] and J.M.S.J.Bandara [2]

Accurate real-time information provision and short-term predictions of traffic parameters such as volumes, travel speeds and occupancies, is a research topic that has attracted considerable interest in the literature. This is, at least in part, a result of the increasing penetration of Intelligent Transportation Systems (ITS) technologies in everyday life. ITS technologies, with Advanced Traveller Information Systems (ATIS) and Advanced Traffic Management Systems (ATMS) as examples, attempt to deal with the traffic congestion and travel time problems facing commuters in many urban areas worldwide by better synchronizing traffic signals and by assisting drivers on selecting routes based on accurate real-time information on traffic conditions.

Objective of this research was to evaluate the Dynamic Travel Time and Modify the Origin-Destination Flows with latest traffic flow data obtained from minimal number of link counts within the network. Methodology in satisfying the research objective has been developed by a Dynamic Program (Dynamic Travel Time Discoverer - DTTD) to collaborate with analytical software widely used around the world. Methodology was developed to estimate the link flows and calculate the Travel Time while giving opportunity to modify the Origin Destination (O-D) Flows according to the latest information. During the dynamic programming, O-D and Flow matrices are read by the program and calculate the total link volumes according to the above matrices and store in arrays. Secondly, developed Akçelik Speed-Flow model uses to convert total flow values into Travel Time values and case studies have been carried out to validate this model to Sri Lankan conditions. This model produces significantly improved traffic assignment run times and provides more accurate speed estimates which lead accurate travel times to assure the objective of identify the best path based on travel time using minimum real time information available. As an another option, program enables user to modify the link flow values with latest traffic data from minimal number of link counts and re-write the Base Flow matrix with the updated values. When the program re-runs, it concludes the shortest path in travel time basis with the latest updates. In Conclusion, the estimation of link flows and modifying the O - D flows can be performed by two stages modal and travel time projected by the improved speed flow relationship. Projected travel time facilitates the selecting best path or the alternative for the user destination. Furthermore, integrate a method which will automatically update the system data base with the latest traffic data corresponding to road links and give the most up-to-date best travel time path to the road user is proposed as future development.

Keywords: *Intelligent Transportation System, O - D Flow, Link Traffic Flow, Travel Time*

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Applicability of HCM 2000 & 1986 to Determine the Level of Service in Urban Arterial Roads, Sri Lanka

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R.P.P.Sumanathissa[4]

The objective of this research is to identify the applicability of Highway Capacity Manual (HCM)to determine the Level of service in urban minor arterial roads in Sri Lanka.

HCM has been developed by the transport research board, USA. Currently most of the local road development agencies use HCM for capacity analysis of roads. There have been no researches carried out to identify the applicability of HCM to the Sri Lankan condition. To depict the quality of service of the roads quantitative measures of a traffic stream are required. Level of Service (LOS) is a quality measure describing operational conditions within a traffic stream, generally in terms of service measures such as speed and travel time, freedom to maneuver, traffic interruptions and comfort.

Six LOS are defined based on service flow rates of roads. Letters designate each level from A to F with LOS A representing the best operating conditions and LOS F the worst. Though the local roads have acceptable LOS, the results obtained from both HCM 2000 and1986 have not reflected it.

It is required to identify the factors which affect the LOS. For that a sample of two way - two lane roads were selected. For the selected sample flowvs.density curveshave been developed by considering traffic data and speed survey data. Based on the literature findings and data collected from the field, six LOS for the urban minor arterial roads have been defined.

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Features and variables of quantifiable measures to be used in quantifying walkability

Chamali Hewawasam[1], Saman Bandara[2] and S.C Wirasinghe[3]

Pedestrian facilities in an urban area have a significant influence on the traffic flow and socio-economic environment. Walking is considered as the most efficient mode of transport for shorter distance; it is environmentally friendly, requires minimal energy, has no direct financial cost and is accessible to all irrespective of age, gender and ability if facilities are provided appropriately. Communities with good pedestrian facilities will enhance the quality of life of the people. Measure of "walkability" has been used to evaluate pedestrian facilities. Majority of such measures are qualitative in nature and rank road segments based on the level of service concept. A recent attempt to develop a scorecard based on measurable aspects of walkability is available but it focuses only on comparing roads based on the facilities available for pedestrians. However, walkability is not only about pedestrian infrastructure and it has more elements while pedestrian infrastructure being one of them. In this research four main elements of walkability have been identified as infrastructure, destination, journey and environment. A complete walkability evaluation criterion must address all these four elements. Hence with those four elements of walkability, a through literature review on the walkability models so far developed has been carried out in order to identify quantifiable measures of walkability. A set of six quantifiable measures of walkability have been identified as connectivity, proximity, density, infrastructure, land use and environmental and safety. Finally, the features and variables of those identified measures have been identified and offers in this paper to be further reviewed. It is expected to use these measures in developing a model to prioritize pedestrian facility requirements in an urban area.

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Development of Driving Cycle for Sri Lanka

Isuru Gamalath[1], Chrishen Fernando[2], Uditha Galgamuwa[3], Loshaka Perera[4] and Saman Bandara[5]

A driving cycle is a speed time profile which represents the driving characteristics of a selected area. This can be of use to legislative and non legislative purposes such as development of emission standard, determination of fuel consumption, etc. Established driving cycles such as European driving cycle and United States driving cycles cannot be used in Sri Lankan context as the traffic constituents, driver behaviour and road conditions vary significantly that from the conditions of those countries. Hence the objective of this research is to develop a standard driving cycle(s) which represent urban and rural conditions in Sri Lanka and to establish emission standards in future based on such cycle(s).

To achieve stated objectives, it is necessary to collect and analyse on road speed-time data on a selected route which will represent the typical driving pattern of an urban or rural condition. Due the restriction of time and resources, this study was limited to development of driving cycle for urban condition and for light duty vehicles. However, this study would facilitate further studies on this area and development of driving cycles for urban, sub urban, rural and express way conditions and this could be of great use for traffic engineering studies, road safety and sustainable development.

A sample driving cycle was developed based on the time series data collected on the Galle Road, section from Katubedda to Fort. Due to the time constraint, on board method was used to collect data using a hand held GPS device. More than 30 samples were collected in this section during different times of the day and different days of the week to represent many prevailing traffic conditions at this urban road section.

Keywords: driving cycle, emission standard

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Study of Fuel Consumption Efficiency of Vehicle Type in Sri Lanka

D.A.S.Jayasekera[1], Mampearachchi W.K.[2]

Road transportation is the dominant mode of transportation in Sri Lanka. The vehicular fleet in Sri Lanka is divided in to two categories as Petrol and Diesel. The highest expenditure in the country is spent for the imported gasoline. Studying of the fuel consumption rates for each and every vehicle type in the country is an essential need to forecast the expenditure for the fuel in future. Fuel consumption is the amount of fuel used per unit distance; litres per 100 kilometres (L/100 km).

The study was conducted to survey the fuel efficiency of petrol and diesel vehicles in the whole country. The data for fuel consumption was recorded at selected fuel stations in each Executive engineers division to cover whole country. The data was collected from 6.00am to 6.00pm. Consumption was recorded from each vehicle type. The results revealed that the petrol vehicles; i.e motor cycles and three wheelers are running with their highest fuel efficiency in North Central Province while cars, jeeps and passenger vans have the highest fuel efficiency in North Western. The lowest fuel efficiency for petrol vehicles is obtained in Uva Province and in Eastern Province except for Motor Cycles. When considered diesel vehicles the highest fuel efficiency is in North Western Province except for buses, pickups and trucks. Estimation of fuel efficiency with respect to district and EE division were estimated. Study shows that fuel efficiency can be used to evaluate the condition of road network within the district or EE division.

Keywords: Fuel Efficiency, Sri Lanka, Data Collection, Vehicle Classification

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