#1 Long-Term Business and Land Development Impacts of Access Management: Minnesota Interstate 394 Case Study

David Plazak- Iowa State University, Center for Transportation Research and Education, Iowa State University
Howard Preston – CH2M Hill, Inc. 1380 Corporate Center Curve, Suite 200 Eagan, Minnesota USA

Synopsis

Understanding the relationship between changes in transportation infrastructure systems and the surrounding commercial economy is important to the successful completion of improvement projects. Owners of businesses located along major highway corridors being considered for improvements often suggest that any change to their existing street network will result in one or more of the following adverse impacts – reduction in property values, reduction in retail sales or failure of their business. This is particularly true when direct access between the roadway and commercial land parcels is modified and controlled. Highway agency staff may be faced with these comments at any point in the project development process ranging from early (corridor planning or environmental documentation) to late (real estate acquisition or condemnation proceedings). However, no matter when these comments are made, project staff has often not been able to provide a strong response because there is very little actual information regarding the economic impacts associated with roadway improvements and none of this information is was developed in an area near the project.

In the United States, Iowa has documented the effects on retail sales and business turnover associated with access management projects. Texas has documented changes in property values in a limited number of improved urban arterial corridors and Kansas has conducted before and after studies of a very limited number of parcels. This information is consistent and is intriguing because of what is indicated (little or no adverse economic impacts to most individual businesses.) This literature is certainly a good start in defining expected business impacts. In order to expand the literature, the Minnesota Department of Transportation (Mn/DOT) has recently conducted a comprehensive and systematic analysis of the economic and business effects associated with the conversion of arterial US Highway 12 (also called TH 12) to freeway-standard Interstate 394, between Minneapolis and Wayzata in the Twin Cities metropolitan area in the Midwestern United States.

The I-394 study process involved two key steps. First an overview was developed covering both the transportation (volumes, speed and traffic operations) and business conditions (property values, employment, business turnover and property development trends) in the entire corridor before and after conversion. The second step, similar to the previous work done in Iowa and Kansas, focused in on the details (travel patterns/times/distances, land use, property values, business turnover, etc.) associated with a non-scientific, representative sample of parcels in the corridor. Individual parcels were selected by a panel of Mn/DOT staff and the State of Minnesota Attorney General's staff. The selected parcels represent a cross section of business types in the corridor, including, office, auto dealerships, retail, hospitality, sit-down and fast-food restaurants, and convenience/gas stations. Secondary data were gathered and in-depth interviews of business owners were conducted.

Key findings of the I-394 study are as follows. All transportation performance measures including mean travel speed and crash rate improved as a result of the conversion of US 12 to a limited access Interstate freeway, even though traffic volumes almost doubled due to growth in both the corridor and the region. The business performance measures also improved – the amount of vacant land in the corridor has significantly declined, new businesses have steadily been added, business turnover was below statewide and national averages; employment is up as are adjacent commercial land values. Interviews with fourteen of the selected business owners/managers indicated that most are doing well and most agreed that the I-394 corridor is a good place to do business even after much greater control of direct land access was put in place. These results are consistent with the findings of the previous research and indicate that the dire predictions of a few of the business owners prior to construction about long term adverse economic impacts associated with the conversion of US Highway 12 to I-394 did not prove to be true.

#2 Italian Multimodal Transportation Corridors: Railway - Motorway Interference

Matteo Bozzetti, C. Lotti & Associati
Franco Policicchio , C. Lotti & Associati
Giampiero Giordano, Cepav Due – Consorzio Eni per l'Alta Velocità
Lorenzo Domenichini, University of Florence, Civil Engineering Department

Francesca La Torre, University of Florence, Civil Engineering Department

Synopsis

The design decision to contain the relative distance between important transportation infrastructures in order to decrease their impact on the environment and land acquisition may lead to serious safety problems.

There are many cases in Italy in which the High-Speed Railway (AV) lines run close to Motorways for a considerable length. The safety problem related to the risk of a vehicle running off the motorway and potentially invading the railway line and, on the other hand, to the potential hazard for motorway users due to the possible protective structures that can be installed within the dedicated corridor must be analyzed and solved.

In Italy, at present, the possible solutions to the identified problem have been considered; different safety approaches have been developed which have been applied to the followings Multimodal corridors:

- Milano-Torino Section. The safety aspects of that design has been developed in accordance with the document "Safety Criteria Organization Document", practical recommendations done by Italferr. No probabilistic analysis and numerical simulation models have been studied ad hoc.
- Milano-Bologna Section. In this case a study has been done in order to identify and to solve safety problems by using a probabilistic analysis of the potential interference between the infrastructures. As a consequence numerical simulation models have been developed to define standard safety.

  This study has been developed in parallel with the construction of the railway line. Thus often there was the need of changing the already realized or designed structures.
- Milano-Verona Section. This study follows the same criteria of the one of the Milano-Bologna but with two main differences:

  - at the time being, the Milano-Verona Project is still in the approval phase of Preliminary Design (complete of safety study), evaluated by Italferr;
  - in the case of the Milano-Verona the interference is between the AV and three different Motorways, one already existing (as Milano-Bologna) and the others are new infrastructures, still in the Preliminary Design phase. So three different probabilistic analysis and numerical simulation models have been studied for these different type of interference.

The safety analysis of Multimodal corridors needs generalization of the problem, with the aim of achieving an adequate standard of design reference, which can be provided by:

- evaluating the set of data to perform a probabilistic analysis and related numerical simulation models;
- providing a miscellaneous of standard safety sections to be applied after the results of the studies;
- studying (by research, crash test, finite elements analysis) a wide set of standard protection systems which can be developed case by case.

#3 Identifying Urban Road Segments whose Pavement Surfaces Are the Most in Need of Maintenance Works - An approach using Geographical Information Systems

Ulysséa-Neto, I. , Department of Civil Engineering , Federal University of Santa Catarina - Brazil
Matos F. C. , Civil Engineering Postgraduate Program, Federal University of Santa Catarina - Brazil
Marcon A. F., Department of Civil Engineering, Federal University of Santa Catarina - Brazil

Synopsis

Within the urban road pavement management arena, the Town Councils find themselves, with an increasing frequency, before the task of identifying the road segments which present the most critical conditions as far as safety, comfort and vehicle operating costs are concerned. Regarding the condition of the pavement surface, its maintenance is viewed here as a mere intervention to restore its traffic condition, that is to eliminate or mitigate the impact of its defects. This can be justified in a situation where there is an acute budget restriction on pavement maintenance investments and the resources are only enough to keep the road pavement network in acceptable traffic conditions, without further indepth consideration on the pavement structure as a whole.

Initially the paper presents an approach of using a Geographical Information System - GIS for identifying and visualizing the segments of an urban paved road network, whose surfaces are most in need of maintenance works. The road segments surface conditions are assessed by means of a pavement functional index – PFI, which takes into account a set of three types of surface defects thougth to be important to the road users in urban areas, namely : surface depression, potholes and surface cracks. A series of defect weighs has been used to calculate the PFI for each road segment. The Brazilian National Department of Roads - DNER standard procedure for the PFI determination has been adapted to generate IFP values so as to take into account the

total number of defects for each category of surveyed defects. Concerning the potholes, their level of severity has been broken down into three subclasses depending on their sizes. Such finer detail description in measuring this defect is justified by its great influence on the road conditions with regard to comfort, safety and vehicle operating costs.
Apart from the surface defects, it is also taken into account the surface degree of rugosity, here given in terms of its macrotexture, measured by the sand patch test as specified by the American Society for Testing and Materials standard procedure. The road segments macrotextures and their functionalities within the urban network, are then compared to their corresponding legal speed limits in order to check for possible surface inadequacies in terms of skid resistance (safety condition). Last, traffic volumes per lane in each road segment are taken as an indication for the speed of surface deterioration and thus used as a complementary indication of need for a short term maintenance intervention.
A practical application of the pavement surface assessment approach to the City of Joinville – Brazil – is then reported. Using a loose-coupling procedure, the surfaces conditions are determined outside a GIS and inserted into it afterwards as themes for thematic mapping. Maps have been generated for visualization purposes and queries have been made in order to identify the most critical road segments in the study area. The feasibility of carrying out a multicriterial analysis in a rather simple way has been shown, so highlighting the usefulness of the approach for both developed and developing countries.

#4 The Effect of Network Layout on the Reliability of Travel Time
Art Bleukx , Katholieke Universiteit Leuven, Belgium
James Edward Stada, Katholieke Universiteit Leuven, Belgium
Ben Immers, Katholieke Universiteit Leuven, Belgium
Synopsis
Much of the current research in network reliability is concerned with techniques to assess the degree of reliability of a given network. Our paper, on the other hand, is aimed at minimising the consequences of varying network loads and (large) incidents by an adequate *design* of the network. Some of the ongoing research on network reliability is based on a simulation of incidents in a network. By examining the consequences of failures of different links in a network one may detect which links are of primary importance in securing the reliability of the network. This in turn may provide guidance when deciding to upgrade certain network links. Our work takes a similar approach, but focuses on network layout.
In the first sections of our paper we introduce the following important aspects of robustness: redundancy, interdependency, resilience and flexibility. The meaning of these terms as well as their relevance for the robustness of networks is explained.
In the second part we present the results of a series of exploratory simulation exercises. We study three alternative networks starting from a reference network that is loosely inspired on the road network east of Brussels. The performance of the reference network is examined under varying network loads and accident conditions. Then two alternatives to the reference network are introduced. In the first alternative the backbone function of the motorway is emphasised by concentrating more flow capacity onto the motorway. In the second alternative flow capacity is more evenly distributed among motorway and regional roads. Our results clearly indicate that the performance of the second alternative is best under all prevailing conditions.

#5 Chemical and Mechanical Reliability of Sub-Grade Layer Built with Demolition Waste Materials.
Portas S., Dipartimento di Ingegneria del Territorio, Università degli Studi di Cagliari
Synopsis
The use of recycled waste material helps to reduce non-renewable resources used to build roads, and limits the expansion of landfill sites. To recycle waste materials, Italian policy (Decreto Legislativo n°22 5/02/1997 and integrations) requires a detailed knowledge of their chemical, physical and mechanical characteristics.
The aim of this research is to assess the performance of C&DW aggregates from the chemical, physical and mechanical point of view and to provide useful information to develop guidelines for the proper use of construction and demolition waste (C&DW) materials for road sub-grade and foundation layers.

Previous research, conducted on an experimental road, has shown C&DW materials to possess good physical characteristics and satisfactory mechanical performance to construct both sub-grade and foundation layers of road superstructures. The research has been extended to include chemical laboratory analysis and to add more in situ tests with different C&DW streams.
Different chemical laboratory analyses were carried out to determine the potential leaching characteristics of recycling materials. Tests performed included the "16-day leaching test", "acetic acid test" and "carbon monoxide test", with all results showing negligible impact to human health.
Also, to evaluate long term mechanical behaviour, both plate and dynamic plate load tests have been performed. To date, results have shown that mechanical performance has improved with time.

#6 Computer Based Linear Scheduling Application for Highway Construction Planning

Dell'Acqua G. , Department of Transportation Engineering, University of Naples "Federico II"
Lamberti R., Department of Transportation Engineering, University of Naples "Federico II"
Discetti P., Department of Transportation Engineering, University of Naples "Federico II"

Synopsis

Since the early 1960s many techniques have been developed to plan and schedule linear construction projects. However the bar charts and the network diagrams overshadowed the others. As a result, these techniques developed into powerful and effective tools that are today. However, those techniques are suitable for many types of projects but they do not fit for linear constructions. Linear projects are typified by activities that must be repeated in different locations such as highways, railways, and airports.
Road construction works can be divided into three main categories: earthworks, pavement laying and structure building.
By earthworks we mean all those works aiming at modifying the ground morphology, whether this is done on the ground surface (diggings or excavations and embankments), underground (trench digging, wells and tunnels) or underwater (structures being built by permanently working under the water level).
Pavement laying consists of using materials whose properties have been normalized using complex techniques. Instead, building protection and completion structures means working at erecting constructions such as supporting walls, bridges, overpasses, side ditches, road drain wells etc.
Recently, there has been renewed interest in linear scheduling. Much of this interest has involved a technique called linear scheduling method. Only recently has there been the ability to calculate the controlling activities of a linear schedule, independent of network analysis.
In this paper the authors propose the results of a computer based linear scheduling application for highway construction project management.
The ultimate product of this research is a Linear Scheduling prototype (UNaLSS – University of Naples Linear Scheduling Software) comprised of models, procedures and software tools that allow for implementation of the linear scheduling method. This software is able to allow planners to visually plan highway construction projects, to calculate the controlling activity path of such schedules and to print reports of the status of the schedule.
The paper describes the software that was developed by the research, its documentation and example for an Italian case study that was scheduled using this prototype.
In addition to the software, the authors propose to road agencies and contractors the utilization of linear scheduling for highway construction management. With this computer tool, road agencies will be able to integrate the software with its current project management tools improving the existing methods.
For complete implementation of UNaLSS additional modules and further research have to be developed. Two of the proposed modules are the cost and resource analysis modules, which would allow project schedulers to calculate the minimum additional cost to reduce project delays and to optimise resource allocation. This additional capability will provide the linear scheduling method with the statistical analysis tools comparable to those of network diagrams.

#7 Feasibility of a high-speed railway network on the main corridors of the countries recently incorporated into the European Union

Prof. Dr. Eng. Andrés López Pita, CENIT (Center for Innovation in Transport)

Dipl. Eng. Carles Casas Esplugas, CENIT (Center for Innovation in Transport)
Dipl. Eng. Adrina Bachiller Saña, CENIT (Center for Innovation in Transport)
Dr. Eng. Paulo Fonseca Teixeira, CENIT (Center for Innovation in Transport)

Synopsis

Over the last two decades railways have made important efforts among the EU-15 countries to improve the quality of daytime inter-city train services. In particular, this effort has been devoted to the construction of new infrastructure suitable for high speed traffic.
The incorporation of new countries into the European Union to constitute the EU-25 allows us to consider the convenience of approaching the railway policy in the CEEC (Central and Eastern European Countries) space in a similar way to the policies carried out in the EU-15.
The paper analyses the experience available, synthesizes the guidelines used in the EU-15 countries and applies them to the countries that have recently joined the European Union to form the EU-25.
The conclusion of the research, carried out by the authors at the Center for Innovation in Transport (CENIT) during the year 2004, warns of the risks of a direct extrapolation of the EU-15 countries' experience to the Central and Eastern European Countries.

#8 Using IRI Measurements for Calculating German Planograph Outputs

Moshe Livneh , Professor Emeritus, Transportation Research Institute, Technion-Israel Institute of Technology

Synopsis

Smoothness has become the primary measure by which the traveling public determines and evaluates the quality of both newly constructed and rehabilitated pavements. Thus, striving for improved initial smoothness is becoming a worldwide endeavor. Numerous investigations have conclusively shown that even small improvements in initial smoothness provide significant increases in the long-term performance of the pavement surface with respect to roughness progression and long-term cracking. For these reasons, the Israeli Public Works Department (IPWD) has included strict roughness specifications in its recent, first, long-section, inter-urban, concrete road, consisting of a 4-lane stretch over a 7-kilometer length (on Route 3). This project was undertaken as a joint venture between a local asphalt-paving contractor and a well-experienced concrete-paving contractor from abroad (Germany). The IPWD utilized California-type profilograph outputs to serve the new roughness specifications. The reason for using this particular profile-measuring device stemmed from the rich experience acquired with it across the U.S. and Canada. For practical reasons, however, the German contractor on this project substituted the California-type profilograph with a German planograph of the Riedhofer Messtechnik V. 0.12 type.
In addition to the use of this German planograph, IPWD initiated its own roughness measurement by utilizing the Road Surface Profiler (RSP), a modern measuring machine equipped with optical distance-measurement devices (laser sensors) and accelerometers. The RSP machine is capable of measuring, calculating in real-time, displaying, and storing on a computer hard disk longitudinal road profiles and roughness data in terms of IRI (International Roughness Index). Thus, the output of this machine also enables virtual runs of the California-type profilograph and the German planograph on the measured longitudinal road profiles in order to calculate two key values: (a) the Profile Index (PI) (i.e., the roughness measures associated with the California-type profilograph) and (b) the vertical deviation (VD) (i.e., the roughness measures associated with the German planograph).
This paper shows the complete method of these virtual runs and their relevant equations. It also includes statistical studies comparing the IRI outputs obtained from the RSP machine measurements with the California-type profilograph and the German planograph outputs obtained from the virtual runs of these two measuring devices. Finally, a comparison of these outputs enables an evaluation of the German requirements for roughness in terms of the American and Canadian requirements. Conclusions and tentative recommendations on this matter are given.
In essence, the conclusions derived are as follows: (a) the model developed for calculating the VD (associated with the use of a German planograph) from the longitudinal road profiles that were measured with the RSP (associated with the use of IRI outputs) seems to be adequate; (b) the IPWD roughness criteria associated with the PI or IRI measurements are stricter than the German roughness criteria, which are associated with the VD measurements, even without taking into account the replacement actions that are compulsory in the PI and IRI criteria, but not in the VD criteria; (c) the German planograph, given its present German requirements, is capable

of detecting localized roughness only, not of detecting continuous roughness along a pre-defined, substantial longitudinal distance; (d) the use of IRI outputs (both IRIB100B and IRIB10B) to characterize the roughness pattern of a given road is most appropriate when the use of the German planograph can substitute for the use of the American straightedge; (e) the use of the Local Roughness Deviation (LRD) criterion, suggested by the AASHTO procedure, cannot be replaced by the IRIB10B criterion as some Israeli agencies suggested by and the use of the VD criterion (associated with the use of the German panograph) cannot replace the suggested AASHTO procedure. To sum up: the German planograph may be used as a substitute for the American straightedge. When the German planograph is applied, the roughness criteria associated with the American straightedge (such as those described by USACE) should also be applied.

#9 Travellers' Attitudes to Travel Time Variability: Inter-Modal and Intra-Modal Analysis

Y. Hollander, Institute for Transport Studies, University of Leeds

Synopsis

A major feature of any reliable transport system is a low level of unexpected travel time variability (TTV). The ability to identify travellers' attitudes to TTV and to ascribe monetary values to their preferences is crucial for the assessment of proposed schemes that might have reliability effects. Past research has not yet overcome the issue of whether the effects of TTV on travellers' behaviour are fully explained by their trip scheduling considerations. While there is evidence that this is the case for car users, it has been shown that railway users are also influenced by the inconvenience caused by TTV per se; for bus users there is hardly any evidence at all. There is in particular lack of discussion about the distribution of preferences among individuals. The current paper investigates the attitudes to TTV and scheduling considerations of car, rail and bus users, based on a survey held in the city of York, England. Multinomial Logit and Mixed Logit models for the choice of departure time are presented. These models account for both the inter-modal and the intra-modal dimensions of the variations in scheduling preferences among travellers. Different formulations of the Multinomial Logit model and different distributions of the Mixed Logit model coefficients are analysed. Some drawbacks of the different formulations are illustrated. It is shown that mean-variance formulations undervalue the effects of TTV; using mean-variance models in scheme appraisal might prevent an important source of benefit from revealing itself, and should therefore be strictly avoided. The models demonstrate that travellers of all modes penalise early arrival to their destination at a similar level as they penalise the mean travel time, but the penalty on late arrival is much higher. Car and bus users differ from each other mainly in their attitudes to lateness, whereas rail users place much higher penalties on all the examined variables. In addition, it is shown that the use of normally-distributed coefficients in a Mixed Logit model results in irrational monetary values. Triangularly-distributed coefficients lead to more reasonable estimates, although the occurrence of some extreme values should be still treated with suspicion. Recommended ranges of the willingness to pay of car, bus and rail travellers are derived.

#10 An Investigation into the Effect of Composition on Performance of Penetration Grade Road Bitumens

Part 1: SARA Analysis

Zoorob S.E. and Airey G.D., Nottingham Centre for Pavement Engineering, The University of Nottingham, U.K.

Synopsis

This paper forms the first half of an investigation into the effects of the chemical composition of penetration grade road bitumens on performance, in particular their ageing properties. The paper briefly reviews evidence from the literature suggesting that bitumens having the same grade, but originating from different crudes, can perform quite differently when subjected to thin film oven ageing tests. Simple explanations of the ageing mechanisms are presented based on analysis of changes that occur amongst the various bitumen fractions produced by chromatographic separation or fractional precipitation techniques. Bitumen samples having several grades, from Middle Eastern and Venezuelan sources were tested in this investigation in their virgin, short term oven aged and following interaction with crumb rubber. All the samples were fractionated into their saturates, aromatics, resins and asphaltenes using TLC-FID analysis. The results show consistent differences in the percentage of saturates and aromatic hydrocarbon fractions between Middle Eastern and Venezuelan bitumens. As expected, an increases in the asphaltene contents as a result of ageing was shown for all bitumens. On the

other hand, ageing seems to have a different effect on the saturate fractions of the two bitumen types. The colloidal instability coefficient was also shown to be a useful tool in highlighting differences between the two bitumen types. The paper describes the principles of operation of an Iatroscan, sample preparation steps and analysis of results. Possible sources of error and scatter of results is also described together with recommendations for improvements.

#11 An Investigation into The Effect of Composition on Performance of Penetration Grade Road Bitumens. Part 2: Biomarker Analysis

Zoorob S.E., Nottingham Centre for Pavement Engineering, The University of Nottingham, NG7 2RD, U.K.

Synopsis

In the first part of the investigation several grades of penetration grade bitumens from two sources were subjected to SARA analysis. Differences in response to ageing of the bitumen samples from the two sources were then investigated in terms of changes occurring to the proportions of saturates, aromatics, resins and asphaltenes. In this part of the investigation, it was decided to investigate, from a petroleum geochemical perspective at a more detailed level, the chemical differences in the make up of the bitumens. The bitumen samples were fractionated using column chromatography and the aliphatic fractions were subsequently subjected to Gas Chromatography (GC) and Gas Chromatography Mass Spectrometry (GCMS) analysis. GC analysis on its own was found not to be a suitable test for penetration grade bitumens. Using GCMS (ion m/z 85) it was possible to show significant differences between the n-alkane distribution of Middle Eastern and Kuwaiti bitumen samples, even though they both originate from the same source/depositional environment. Using GCMS (ions m/z 191 & 217) it was possible to analyse the hopane and sterane distributions respectively of the saturated hydrocarbon fractions of all bitumen samples. Fundamental differences were noted in the abundance and distribution of biomakers in the chromatograms between the Venezuelan and Middle Eastern bitumens. A range of biomarker diagnostic ratios was investigated allowing some analysis of thermal maturation and depositional environments of the organic rich source rocks (from which the oil was generated) to be carried out. Some potentially useful trends in diagnostic ratios were observed as one moves progressively across the various grades of bitumens for any one source, and between samples in the virgin state and those that had been subjected to age conditioning.

#13 A risk assessment procedure for the safety management of airport infrastructures

Sascia Canale, Department of Civil and Environmental Engineering, University of Catania, Catania, Italy
Natalia Distefano, Department of Civil and Environmental Engineering, University of Catania, Catania, Italy
Salvatore Leonardi, Department of Civil and Environmental Engineering, University of Catania, Catania, Italy

Synopsis

Today, the overall yearly number of accidents, incidents and serious incidents in civil aviation is some 50 worldwide, with an average of 13000 victims.
Experience has demonstrates that before an accident occurs various incidents and numerous failures reveal the existence of safety risks.
In this context, risk assessment and risk management are important tools for understanding risks, defining acceptable levels of risks, and reducing risks.
Risk management is the systematic application of management and engineering principles, criteria and tools to optimize all aspects of safety within the constraints of operational effectiveness, time, and cost throughout all mission phases.
Risk assessment is the process which associates “hazards” with “risks”. When we know the various impacts a hazard may have on our mission and an estimate of how likely it is to occur we can now call the hazard a risk. Risk is the probability and severity of loss from exposure to the hazard. The assessment step is the application of quantitative or qualitative measures to determine the level of risk associated with a specific hazard. This process defines the probability and severity of hazard based upon the exposure of personnel or assets to that hazard.
The outcome of the risk assessment process is a list of risks developed from the output of the hazard identification process. The first risk is the most serious threat to the mission, the last is the least serious risk of

any consequence. Each risk is either labeled with its significance (high, medium, etc.) or the section in which it is place is labeled. This allows us to see both the relative priority of the risks and their individual significance.
In this paper the authors propose an original risk assessment procedure for any airport.
The original points in this methodology are: the causes identified associated with each hazard by analysing other studies and both National and International databases; the hazard probability assessment through to the cumulative probability of the causes identified using the Total probability theorem; the conditional probability assessment was established by analysing the National database for causes belonging environmental and surface conditions categories and by analyzing the International database for causes belonging aircraft performance characteristics category; hazard severity assessment was established by analysing of National database.

#14 The reliability of the urban road network: Accident forecast models

Sascia Canale, Dipartimento di Ingegneria Civile e Ambientale. Università degli Studi di Catania
Salvatore Leonardi, Dipartimento di Ingegneria Civile e Ambientale. Università degli Studi di Catania
Giuseppina Pappalardo, Dipartimento di Ingegneria Civile e Ambientale. Università degli Studi di Catania

Synopsis

The fundamental characteristic of the Italian road accident is the highest rate of urban crashes: 73% approximately of the total of the accidents happens in urban contexts where, against the European average, every day are recorded more than 4,2 died; moreover, more than 50% of the totality of urban accidents, happens at the intersections, which represent dangerous points.
Concentrating the study to the urban intersections, it has been characterized the relations existing between the number of accidents and the relative characteristics to geometry, to traffic regulation systems and to traffic flows.
Starting from the theoretical support constituted by various international studies, as the ones executed by the Federal Highway American Administration (Statistical models of at-grade intersection accidents. Technical report. November 1996), a study campaign in Catania has been carried out.
In particular, the accidents in the space of three years, the traffic flows on the arteries situated inside the city area, the geometric characteristics and the traffic regulation systems of 400 intersections (the statistical sample) were collected.
The data processing have been conducted putting exclusively into account the accidents with injuries, happened on five types of urban nodes (four-leg uncontrolled, three-leg uncontrolled, four-leg STOP-controlled, three-leg STOP-controlled, four-leg signalized).
Two general types of statistical models were applied to the accident data in this study: (1) a lognormal regression model and (2) a loglinear regression model (Poisson regression).
The accident forecast models have an elevated degree of significance; moreover the contribution supplied from some variable relative to geometry and the traffic regulation systems is equal, and sometimes greater, that one supplied from the vehicular capacities.
The proposed methodology is a useful instrument for the effective understanding of the accident case in the urban intersections and for the eventual organization of improving intervention of the total reliability of the same road nodes.

#15 Road lighting: Safety management for urban intersection

Sascia Canale, Dipartimento di Ingegneria Civile e Ambientale. Università degli Studi di Catania
Salvatore Leopardi, Dipartimento di Ingegneria Civile e Ambientale. Università degli Studi di Catania
Giuseppina Pappalardo, Dipartimento di Ingegneria Civile e Ambientale. Università degli Studi di Catania

Synopsis

Road intersection reliability depends on several factors, between which road lighting assumes particular importance.
This must reveal the presence of intersection, the directions of the confluent and diverging roads, the position of the sidewalks, the presence of pedestrians and other customers, the obstructions, the movement of the vehicles.
Experimental studies have demonstrated that the visibility of an object on the road depends mainly on the level of luminance of the road, but also on the uniformity of luminance and from the produced conditions of dazzle from luminous sources.

In the intersections, the criterion of the luminance is not always applicable because the observation distances are small or for the calculation difficulty if the intersection is wide; in these cases, then, is used the criterion of the illuminance.
The analysis, lead in our research, consists in the survey of the values of luminance and illuminance of 252 junctions, belonging at the city of Catania, and in the creation of an index to correlate the level of really lighting system with the degree of safety offered from the road intersections.
For every intersection, it has been defined a level of service lighting – technique, from the level A for the intersections to smaller risk of incident until the level E for the intersections to greater risk of incident.
The issues of this research are important because have allowed to find the levels of luminance and illuminance in the intersections and to underline the necessity of detailed study to improve the level of lighting and to reduce therefore the risk of incidents.
The elaborated index, moreover, being born from a general methodology, will be able to concur to extend the safety analysis to all the intersections in varies urban contexts, allowing to improve the liveability, in terms of public safety and of the circulation.

#16 Dimensions of Sustainability
Wendell Cox and Jean-Claude Ziv, Conservatoire National des Arts et Metiers, Paris
Synopsis
Economic studies have shown that effective mobility and access improve incomes both for people and urban areas. At the same time, there is concern that the mechanisms of mobility be sustainable. But public and transport policies have been insufficiently broad in their characterization of sustainability. The principal focus of sustainability policy has been on environmental factors, which are, of course crucial.
But the actions of people and governments are often in conflict with policies adopted for environmental sustainability. As a result, environmental sustainability can, in some situations, be characterized as little more than a statement of intentions that is negated by the actions of people and government. This is principally because genuine sustainability must be acceptable. If policies intended to produce environmental sustainability are not observed by people and their governments, then their objectives cannot be met. Moreover, transport solutions that might be considered sustainable, but which cannot be affordably extended throughout an urban area may produce outcomes inferior to less expensive programs that might be extended throughout the area.
Additional dimensions of sustainability are proposed that should be observed for the objectives of environmental sustainability to be achieved. These would include issues such as public policy trends, preferences as revealed in household behavior, financial capability and infrastructure alternatives.

#17 The Functional Requalification Of A Transport Infrastructural System: Objectives, Criteria And Intervention Priorities.
Maltinti F., DIT – University Of Cagliari
Annunziata F., DIT – University Of Cagliari
Synopsis
It can be said that, despite the clear need of a general modal readjustment of the transport system, road infrastructures will continue to absorb the majority of the movements of passengers and goods, at least in the short-middle term. This forecast will be predictable till the lacks that have contributed to determine the success of road transport are corrected. Therefore, we need to solve problems of management and adjustment of the existing road net, that are particularly important, both for the effects induced on the production system and for the consequences they determine from a social and environmental point of view. Hence the need to proceed to a functional redevelopment of the existing road net, a net that distinguishes the territorial functions and the functions accomplished, within the road net one belongs to, by road connections, ensuring an equal offer and level of service.
The guidelines of the redevelopment interventions that have been proposed are as follows:
a) the transport system and its road net must be adjusted to the social-economic situation of the territory and to its development principles and must respect, safeguard and enhance the peculiar historical-environmental realities, in harmony with a general economic planning. The planning of the transport system should correspond

to a global vision of the economic development process in which the intervention is placed: the planning of a road doesn't have an independent configuration, it is an integral part of the territorial planning;
b) every component of the system plays a role that corresponds to its technical and economic characteristics and all the components, hierarchically organized, contribute to define the functional territorial structure to the prearranged social-economic structure. The definition of such integrated system must be achieved through the optimization of the available resources, paying great attention to the use and reuse of those that already exist on the territory;
c) the transport system must be used to manage the localization of the activities, that is the crux, not only of town-planning problems, but also of those concerning traffic.
Undoubtedly, the objectives of an intervention programme on an infrastructural system must be the following:
- road safety;
- connectivity and level of service of the road net;
- cost-effectiveness of the intervention;
- equal distribution of road system services, inside a given territory.
In order to pursue integration and intermodality, the functional redevelopment must be aimed at achieving the connectivity of the infrastructural system for the followings reasons:
- the increase in the connectivity of transport networks is fundamental to support the formation of a more reticular territorial structure and to achieve a better distribution of the development;
- changes in the connectivity, due to an unequal development of transports, are the cause of some of the main obstacles and penalizations that interfere with the distribution of the development.
It can be said that a hypothesis of management of an existing road system that includes:
- interventions of ordinary maintenance;
- interventions of extraordinary maintenance;
- new works, aimed at providing the infrastructural system with integration and intermodality,
has to refer to the above-mentioned basic concepts and objectives.
The work that is being proposed deals with those issues and aims at explaining its contents as well as giving answers, specifying the objectives, the intervention criteria and a possible method to define the priorities.

#18 The Open Planning Process

Public Participation and Stakeholder Consultation in Infrastructure Projects, Dipl.- Ing. Alexander Walcher, ASFINAG, Head of Planning Department

Synopsis

In the process of motorway construction Environmental Impact Assessment (EIA) has become a crucial part of the planning process. For this purpose ASFINAG has implemented the so called “Open Planning Process” to meet the needs of environment, affected people and cost efficiency.
Involving stakeholders and the population affected by the planning and execution of road construction projects at a very early stage has become an essential factor in the acceptance and understanding of road construction. Infrastructure projects need to be carried out in a way that is transparent and easily understandable for lay people, by exchanging information with the population concerned but also by actually involving it in the planning process.
Since 1999 ASFINAG has been drawing up environmental relief measures, together with the population concerned on-site, for the ecologically sensitive areas along the summit level stretch of the Tauern Autobahn as part of the construction of the second tunnel tubes through the Tauern and Katschberg mountains.
Proposals were addressed as part of an iterative process, and the pros and cons of "extreme solutions" such as mile-long tunnels discussed; ultimately this process resulted in an entirely objective approach to what had initially been a highly charged emotional issue. By involving the population in the planning process it proved possible on the one hand to achieve a greater level of understanding among the local communities for the implementability of measures and, on the other, a greater acceptance of the project as a whole. The representatives in the work groups also acted as multipliers in the local communities, which meant we were also able to achieve a more objective discussion throughout the region as a whole.
The view that such an approach simply makes projects far more expensive is essentially incorrect; indeed, nowadays projects are generally planned using other standards with regard to environmental repercussions. The

advantage of what is referred to as the "open planning process" is undoubtedly the implementability of projects drawn up in this way and above all the greater acceptance of road construction in Austria as a whole.
One of ASFINAG's objectives has always been to make planning transparent and easily understandable. A whole range of instruments has been established to involve the general public, and these instruments are regularly adapted and modified to suit individual projects. Ultimately the public's participation cannot be achieved using a purely standard programme. Each project imposes different requirements on its promoter. It takes a precise and meticulous analysis of the circumstances and situation on site to bring off the difficult balancing act between successfully involving the population and simply overwhelming it with information.

#20 The Relations Between Regional Economic Development And Evolution Of Transport Demand In Italy

Agostino Cappelli, Università IUAV di Venezia,
Alessandra Libardo, Università IUAV di Venezia
Silvio Nocera, Università IUAV di Venezia

Synopsis

The field of transportation plays an essential role both in the economy and the society: a direct relationship between growth of the Gross Domestic Product (GDP) and tendency of the transport demand can be therefore reasonably stated.
First of all, it is quite logical to assume that the economic growth induces person and freight mobility: increasing the production of goods (either in absolute or in added value) means inducing bigger movements of persons (in order to produce and to consume) and visible trades of freight.
The second reason is both practical and historical: even if lots of social and economical phenomena are strongly influenced from their initial conditions, a wide-ranging regularity does not completely guarantee an univocal future evolution.
In the present case, on the contrary, both an in-depth study of Leontieff's input-output matrices and the reading of the available data and estimations confirm that the GDP and transport demand have had concordant trends. In other words, the whole economical system was shown to have the "quality" of stability: its floating data population evolves through intermediate states, which can be observed and controlled. In Italy, this procedure was introduced for the first time by Wassily Leontieff and Paolo Costa for the 1986 General Transport Plan (PGT). The method was then nationwide used in various studies, becoming a standard procedure, which often applied the same Leontieff's evolution ratios (recently, it was expounded again to national level - Iannone, 2003). The same procedure is been used in recent European Union White Paper (2001).
This study intends to verify the correlation level between variations in GDP and variations in national traffic flows in Italy also on a regional scale. The values of GDP, from 1980 to 2003, are related to the flows of passenger and freight traffic (passenger-km, tons-km) by rail (source: Trenitalia) and motorway traffic road (source: Italian Association of Motorway and Tunnel Concessionaire Company, AISCAT) over the same period. Having confirmed the substantially linear dependency and the very high index of correlation of the variables, the respective elasticity function is studied and the elasticity index (relation between demand and GDP) for the four flow variables calculated.
Our analysis shows an elasticity in excess of 1 for road traffic flows (1.71 for passenger traffic and 1.23 for freight traffic) and less than 1 for rail traffic (0.76 for passenger traffic and 0.81 for freight traffic). This means that the elasticity of the road traffic system is considerably higher (for every point of growth in GDP we have a 1.71 growth for passenger traffic and 1.23 for freight). In contrast with the analysis conducted by Leontieff for PGT of 1986 (for both the road and rail sectors systems), the elasticity of passenger flows is higher than that of freight flows in the road traffic sector (the data of 1986 indicate an elasticity of more than 1 for freight and less than 1 for passengers). It should be borne in mind that the calculations for the road traffic system used motorway traffic data, since these are the only uniformly available data over the entire period at issue. Nonetheless, an access to short and medium trip length data, especially that for urban traffic, would probably bring to even higher elasticity values. Indeed, the effect of economic growth would certainly have a stronger effect on short trip passenger traffic flows, in which mobility for reasons of work and acquisition of freight and services dominates, as shown in the latest ASSTRA-ISFORT annual report (2005), according to which "trips within city boundaries, in the period 2000 to 2004, have grown by 12.3% (passenger-km)".

In the case of rail traffic, the lower values of elasticity confirm the loss of competitiveness of the rail system and the growing difference between the two modes.
After analysing the national situation, the study then concentrates on the regional scale level, only for the road system, since regional rail traffic flow data are not available, and only for those regions in which motorway administration is contracted out (16 out of 20).
The obtained results, while requiring cautious evaluation given the use of macro-economic demand forecast models and the considerable terms of extrapolation, enable to analyse with sufficient reliability the progress of demand at the national and regional scales and, in particular, to use the elasticity indexes calculated for the single regional systems.

#23 Assessing and Mitigating the Impacts of Road Network Unreliability

Nicholson, A.J., Department of Civil Engineering, University of Canterbury, Christchurch, New Zealand
Dalziell, E.P. , Department of Civil Engineering, University of Canterbury, Christchurch, New Zealand

Synopsis

Road network unreliability can arise from variations in the supply and/or demand for transport. In major urban areas, where the networks are typically dense and congested, both supply and demand variations occur. Although they are typically of relatively short duration, the social and economic impacts can be substantial. In rural areas, where the networks are typically sparse and uncongested, demand variations are generally not important, but supply variations, which are typically of relatively long duration, can have substantial social and economic impacts. Some countries are actively pursuing methods for reducing those economic impacts. In New Zealand (NZ), for instance, procedures for the economic appraisal of transport projects have recently been extended to include changes in the variability of travel times, with a view to improving the reliability of urban networks and transport services. The reliability of rural networks has also been receiving considerable attention, with the focus being on minimizing the social and economic impacts of network disruption associated with natural disasters, such as earthquakes, volcanic eruptions, storms and tsunamis.
This paper will describe and discuss the measures being taken in NZ to assess and mitigate the impacts of road network reliability, with particular attention to rural (or inter-urban) networks. Much of the work to date has involved the application of risk management techniques combined with scenario analyses, but a difficulty with this approach is deciding which scenarios should be included in the analysis. This difficulty may be overcome via a “walk-through scenario approach”, which involves randomly generating hazard events over a suitable analysis period. This technique does rely upon the probability of hazard events being known, along with correlations between the occurrence of such events (e.g. the probability of a tsunami depends upon whether an earthquake has occurred and the characteristics of that earthquake). An advantage of this technique is that it enables an assessment of whether the greater risk comes from frequent, minor-consequence events, or from rare, major-consequence events (i.e. it does not focus on “worst-case” scenarios and it avoids the potential for misallocating resources). A recent study has concluded that a “walk-through scenario” approach should be employed for an all-hazards risk assessment of the NZ State Highway network, to provide a basis for prioritizing risk management investment in the network.
Recent years have seen an upsurge of attention to Civil Defence and Emergency Management (CDEM) in NZ. This is seen as involving four phases: reduction (i.e. identifying and reducing risks via infrastructure improvement), readiness (i.e. training civil defence staff and installing warning systems), response (i.e. reacting to emergency situation in the short-term), and recovery (i.e. minimizing the socio-economic impacts in the long-term). This paper will also outline a study of how NZ organisations, including the State Highway Authority (Transit NZ), prepare for and react to hazard events, so as to enable full recovery as quickly as practicable.

#24 Probabilistic Risk Analysis in Road Tunnel Safety

Renato Lamberti, Full Professor, Department of Transportation Engineering “L. Tocchetti”- Naples
Maria Luisa De Guglielmo, PhD Student, Department of Transportation Engineering “L. Tocchetti”- Naples

Synopsis

This article suggests a methodology of the risk index assessment connected to the one-way and two-way road tunnel crossing, based on the use of Probabilistic Risk Analysis.

This study is included in the course of an extensive research programme started by the Department of Transportation Engineering "L. Tocchetti" – Naples University "Federico II"; the final goal of this research is the interpretation of the system man-vehicle-road tunnel environment (where service management for users gathers unusual prominence); the started programme also includes an experimental physical and virtual survey of the speed into road tunnel.
We have specialized a general methodology, with applications in different fields of Engineering, on the basis of a detailed and complete database of the car-crashes (reconstructed by Police minutes) occurred between 1997 and 2002 in all road tunnels in the province of Salerno.
Particularly in-depth analysis, carried out until now, has given the possibility to create an event tree for the accident probability determination in both types of the road tunnels (one-way and two-way) and as many fault trees as typical accidental sequences are reconstructed. Besides, we have determined the consequences size distribution (in terms of dead, injured and damages) of occurred accidental events, on a statistical basis.
So we have planned the means for the risk index determination connected to the undesired event in one-way road tunnel accident and in two-way road tunnel accident; after stating the means clearly there will be surely a detailed numerical application realizable only by a close and reasoned data finding, that isn't organized in a proper way to the request of this procedure, concerning the road tunnels (at a national level too).

#25 Analysis of Laboratory Data from Crash Test on Road Safety Barriers

Guido Bonin, Giuseppe Cantisani, Giuseppe Loprencipe, University of Rome "La Sapienza"

Synopsis

Acceptance standards for roadside safety devices have been operational for more than 10 years. All the major standards worldwide requests, for the homologations and the installations of these devices, to pass a full scale laboratory crash test. In these years many tests have been done, so the large amount of data resulting from these activities can be collected and processed with the tools of statistical analysis. This procedure is able to give, using existing data, some hint about the intrinsic rules of this complex phenomena and can be used either in the prediction of unknowns in other crash tests and to evaluate some "strange" results by cross referencing the available data and comparing to the results from statistical regressions. In this paper is presented the database collected and the methodology used to perform the statistical regressions and evaluations, together with the results from this activity on the available databases.

#27 Somaro ITPC: emergency/maintenance crossover point

Didier PEYRARD, Technical Director, Research and Development, SOMARO Group

Synopsis

Introducing the Pivoting ITPC: In 1999, the Directorate for Road Traffic and Safety (DSCR), in conjunction with the Association of French Highway Companies (ASFA), launched a competition to design an improved emergency crossover traffic barrier (metal and/or concrete) in the goal of enhancing traffic safety.
Somaro rose to the challenge, designing a pivoting metal unit that fulfilled all technical specifications.
The new unit makes it extremely easy to create a crossover point in order to swap traffic to the opposite lane in support of emergency and maintenance operations while ensuring maximum safety for workers and drivers.
The unique design of the Somaro ITPC makes it highly useful for swapping traffic in response to accidents or maintenance requirements and directing traffic effectively through its wedge formation.
Unit Characteristics: The Somaro ITPC is designed in the form of 3.5 meter modules to allow for adaptation to crossovers of any length.
A 40 meter wedge-shaped crossover using the pivoting ITPC is made up of the following components:
- Two pivoting units, each on its own rotating base and made up of four 3.5 meter modules positioned on either side of an emergency lane. All steel components are hot-dip galvanised for enhanced protection and have a wedge-shaped profile and internal braces to ensure maximum inertia and shock resistance. The unit base is 90 cm wide from end to end with a height of 80 cm. Every module assembly has six stowable anchor supports to configure the structure for superior shock absorption.

- A specially designed 6 meter long sliding module for opening the emergency lane for response vehicles when required.
- Two 2.5 meter-long end modules for absorbing the effects of expansion attached to either side of the unit for connection to existing barriers.

#31 The 2002 Mechanistic-Empirical Design Procedure for Flexible Pavements: How to Implement it in Italy

Clara Celauro, DIIV - Dipartimento di Ingegneria di Infrastrutture Viarie, Universita' degli Studi di Palermo, ITALY
Lev Khazanovich, Associate Professor, Department of Civil Engineering,. University of Minnesota

Synopsis

A new Mechanistic-Empirical Pavement Design Guide (MEPDG), also known as the 2002 Design Guide, has been recently proposed in the United States. The development of such a procedure was conducted by the National Cooperative Highway Research Program (NCHRP) under sponsorship by the AASHTO. The Design Guide represents a challenging innovation in the way pavement design is performed: design inputs include traffic (full load spectra for single, tandem, tridem, and quad axles), material and subgrade characterization, climatic factors, performance criteria and many others. One of the most interesting aspects of the design procedure is its hierarchical approach, i.e. the consideration of different levels of inputs. Level 1 requires the engineer to obtain the most accurate design inputs (e.g., direct testing of the materials, on-site WIM, etc.). Level 2 requires testing, but the use of correlations is allowed (for example, subgrade modulus estimated through correlation with another test), and Level 3 generally uses estimated values. Thus, Level 1 has the least possible error associated with inputs, Level 2 uses regional defaults or correlations, and Level 3 is based on the default values. A trial structure is then analyzed for adequacy through the prediction of key distresses and smoothness (as a measure of ride quality): if the design does not meet desired performance criteria, the structure must be revised and the evaluation process repeated.
Although evaluation of this procedure is still underway, many State transportation agencies have already begun adaptation and local calibration of this procedure. This paper addresses the key aspects of the design procedure for flexible pavements and the way it can be transferred to Italy.
To implement this procedure for Italian conditions, various issues should be addressed. This includes material evaluation, availability of traffic and climatic data, contracting methods and need of new specifications. In Italy, where pavement design is mostly based on the use of a Catalog, the implementation of the 2002 AASHTO Design Guide or any mechanistic-based design procedure will require a lot of effort, but it will provide a powerful tool accounting for changes in traffic, materials, construction, design concept, climate and so on.

#32 Transport and mobility issues in environmental planning: A forum-based scenario approach in southern ItalyTPT**1**TPT

D. Borri, D. Camarda, A. De Liddo, Dipartimento di Architettura e Urbanistica, Politecnico di Bari, Italy.

Synopsis

Environmental planning is today characterized by an increasingly communicative approach, challenging the traditional strong and absolute rationality of planning, inspired by the new awareness of the complexity of environmental phenomena.
Mobility infrastructure planning and management represents an increasingly crucial aspect of environmental planning. It is in fact essential to boost regional economies and social relations, as well as critical for environmental impacts involved.
Structuring (rather than acritically simplifying) inherently complex issues and problems is a major challenge of mobility planning. The issues of mobility are in fact deeply connected to the way how people perceive and give value to local places. This way of interpreting space does condition (and is conditioned by) people's lifestyles and abilities to find orientation, as well as their very knowledge of places.
The objective is to set up methodologies that take into account the impacts of the modifications of the mobility system on environmental quality and on the quality of life of the citizens. Those methodologies should also consider not only the multiplicity and the difference of the decisional agents involved in policymaking and in drawing the technical aspects of the optimization transportation nets. It should also consider the changes of the processes of space interpretation by the installed communities, involving them in open dialogues.

In this framework, a multi-agent approach is today seen as useful to let local stakeholders interact, locate and share behaviours and knowledge, meanwhile learning from each others' attitudes and knowledge patterns.
Starting from this point of view, the present paper will deal with the management of multi-agent knowledge in public interaction forums, particularly highlighting the mobility issues in a large context. Particularly, this context is the Italian province of Foggia, where a Structural Plan is being carried out since 2003.
In it, an articulated sequence of public forums has been set up, oriented at building collaborative future visions in the environmental domain, with reference to actual regional contexts of the province. In this forum-based framework, in which some future alternative scenarios will be discussed and evaluated, the issues of mobility will be traced through and reflected upon, trying to understand potentials, criticities and suggestions of participatory scenario approaches in mobility planning.
.

#34 Human Element And Design Rules: State Of The Art

Pinna F., Dipartimento di Ingegneria del Territorio - Università degli Studi di Cagliari
Piras C., Dipartimento di Ingegneria del Territorio - Università degli Studi di Cagliari

Synopsis

Between several transport systems one of the most used is the road, for the freedom that such modality guarantees to user, above all in case of good working. The relative statistics, concerning the phenomenon of the accident, attribute to the human factor the responsibility of beyond 83%. This last data has contributed to assume that, within the complex system "man-vehicle-infrastructure-environment", greater importance to the interaction "man-infrastructure", so towards the infrastructure characteristics, the dimension of the section, the visibility, the presence of different vehicles, the perception of the spaces, etc., influencing the control of the vehicle, from part of the users, in more or less favorable environmental conditions.
The road is the environment in which vehicles moves and with which the driver, through the vehicle, interacts. For this reason it is important that the environment transmits, to the user, clear marks, so that the corrected behaviour comes favourite.
Once the functions involved in the guide are defined it is necessary to find the role of these in the design. It is interesting to verify in that way and to that level, within the search and the normative systems, it is dealing with the relationship between technical choices and effects induced on the user. This work proposes to evidence actual state of the art regarding the role assumed from the user in the design, with reference to proposals from the wide panorama of research and of Italian, European and American normative system. The objective of the present article, that constitutes only the first phase of a wide research on the same topic, is to supply an outline of the situation of main design rules, inside of which, are considered the human elements.

#35 Methodology for classifying road yards and reliability of areas near them

Prof. engineer Giulio Maternini, Associate professor of Transport engineering, Department of civil engineering of the University of Studies of Brescia
Dr. engineer Silvia Foini, Expert on technique and economy of transport engineering, Department of civil engineering of the University of Studies of Brescia

Synopsis

The opening and the exercise of a yard are activity, that would have to be subject to the respect of a series of procedures and implementations, assets and liabilities, finalized to the safeguard of which, for varies reasons, can interfere, also episodically or for a short time, on the activity of the yard. For such reason it has been attempted to indicate some elements and lines guides for the companies working in the road sector, currently not subject to some directive or regulations, for the reduction of the environmental impacts produced from the participations that interest the street, with the purpose to introduce *"Environmental Regulations for Road Yards",* than address the choices of the enterprises on the modalities of organization of the street yard and development of the works, and opens the road to an eventual environmental certification. In order to define a methodology for a classification of the yards we have analyzed some possible impacts on the atmosphere without dealing the possible variations on the planning of the traffic in presence of the street yard and, consequently, without to make one appraisal of the costs which had to the eventual congestion of the traffic. This because the planning of the traffic and the external costs which had a congestion do not influence on the methodology proposed for the

classification of the yards. The analysis has been carried out distinguishing the yards situates in urban environment from those in rural environment and considering works of brief duration (to the maximum 48 hours), and works of longer duration (advanced to the 48 hours). In this way it has been attempted to supply a methodology of classification of the street yards (reassumed in an blocks procedure), so that it can be adopted from all those who operate in the street field, characterizing some lines guides for the application of the " *Environmental Regulation for Road Yards* ", than all the operating enterprises in the street field would have to respect, characterizing all those elements and sagacities useful to concur a better control of the problematic ones acclimatize them and a criterion of appraisal of the main impacts (check-lists). In end the Capitolato insertion in special of contract of the two new regarding articles these lines has been proposed guides. The job has been carried out considering the Italian situation and the relative rules, however the defined methodology of job can be applied to various truths, adapting the different normative aspects .

#36 Self Ice Melting Winter Pavements

Gabriele Camomilla, Autostrade per l'Italia SpA
Pierluigi Bernardinetti, Autostrade per l'Italia SpA
Roberto Lanucara, Tecnoroad SaS

Synopsis

Thanks to important developments in draining pavements the disadvantages of driving in the rain have been strongly reduced, and the virtual elimination of the risk of aquaplaning has notably enhanced driving safety.
Moreover, the great versatility of porous materials includes protection for the environment on which a road is built. Such protection includes the noise-absorbing effects of these materials, which, today, thanks to SIRUUS studies, can handle a vast range of sound frequencies and abate them as they are generated.
Having overcome the problems represented by the formulation and reliability of materials as well as the question of reducing costs, the remaining question concerns winter management because in relation to closed pavements, draining pavements require greater attention and immediate action as regards de-icing and snow clearance. This question has delayed the application of functional draining pavements on mountainous sections where, despite their very poor draining properties, ***semigrenu*** pavements are frequently used.
At present winter management requires a special type of salt mix - viscous salts (a sodium chloride and calcium chloride mix) – which while remaining longer on the ground needs double storage facilities and special salt sprinklers. The results are excellent from the point of view of road use but their deployment is susceptible to delays in maintenance action, while operating errors are always possible.
On the other hand, the new technologies to be discussed in this paper produce a considerable reduction in the temperature necessary for the formation of ice (normal ice, verglas or snow), thanks to the addition of proactive fillers in the mixtures that constitute the drainants. Their benefits are:

- the non-necessity of external treatment in cases of verglas or simple ice
- the tolerance of one or two hours' delay in de-icing work with salt-sprinklers in the event of snow.

The use of self ice melting materials guarantee maximum safety because all their actions take place within the body of the draining layer, without extruding onto the road surface. In the past their use with closed mixtures was a cause of concern because, during spring and winter rainfalls, liquids with a potentially slippery effect seeped out onto the road surface.
In addition, the new products behave differently with respect to the past, and therefore the adverse behaviour indicated above no longer applies, and not even in closed mixtures; other investigations on this question are at present underway.
The following research programme was undertaken:

- Mixture tests with active fillers to identify mechanical resistance variations
- De-icing tests (in a climatic test chamber - tests on normal bituminous mixes/ tests with additive)
- Adherence tests on draining surfaces (repetition of tests on normal bituminous mixes.)
- Experimental layer on the A1 near Rome
- Validation for experimental use on critical areas (A7 Genoa)
- Continuation of validation tests for environmental aspects with the development of more durable active agents that do not corrode road structures

The first experimental applications were made in mild climatic conditions in areas near Rome to test environmental behaviour. However, applications for the real verification of winter operations - involving the Apennine section of the A7 Genoa - Milan motorway - where in the context of icing and snow of January valid behaviour is being obtained, which will be duly reported in the final presentation of this paper, which will also add the details on the evaluation tests and the formulations of the foregoing de-icing products.
In future these products may have applications for pedestrian areas and normal mountain roads.

#37 Safety Evaluation: Practical Use Of Collected-Data Vehicle To Obtain Geometric Information Of Existing Roadways

Crisman Bruno, Department of Civil Engineering – University of Trieste
Robba Alberto, Department of Civil Engineering – University of Trieste

Synopsis

Roadway geometric data, user behaviour and crash data provide the main input for developing existing highway safety evaluations. In particular, roadway geometric data can be useful in providing quantitative guidance for alignment consistency and for having an initial indication of critical point presence along a road. Researchers in the University of Trieste have already developed some important relationships between the operating speed V85 and the geometric features of a road, introducing the new concept of CCR - curvature change rate - to evaluate the environmental speed of a road section. To determine the CCR, it is important to have geometric information that can be collected from design, but often design is not available. In this case the only way to obtain geometric data is to carry out a road survey.
This paper presents a new methodology to obtain horizontal road information by the elaboration of a dynamic alignment survey. A collected-data vehicle is used to collect three-dimensional data. The vehicle is equipped with a GPS receiver, a vertical gyroscope and a gyrocompass that provides information about the vehicle position (x, y, z coordinates) and orientation (angle of pitch, roll and yaw). Outputs of instruments are used as input data of a software. The developed algorithms produce the main horizontal geometric data (tangent length, tangent azimuth, circular horizontal curve length with relative radius value and centre position, length of spirals).
The algorithms about the location of transition zones between tangent and circular curve are the most interesting and effective. Two different algorithms are used to find geometric data in both of the following cases: tangent to curve transition and spiral transition.
The software was tested for two-lane rural roads in the north - east of Italy, comparing roadway geometric data (algorithm output) with road as-built data. The quality of this comparison was excellent and the difference between calculated and design data was restricted to a small gap.
This effort demonstrates that it is possible to use digital collected-data information to extract important horizontal alignment features and opens the way for use of the developed software in system geometric deficiency and highway safety evaluation.

#38 Methodology for Determining Transportation Network Connectivity Reliability Under Threats of Terrorism

Pamela Murray-Tuite

Synopsis

Predicting the connectivity of a transportation network in terrorist attack scenarios is a challenging problem. Historical information is often not available for any particular network. Furthermore, in the event of an attack, the network is modified by two entities, the terrorists, who damage network links, and law enforcement agencies, who close links in order to secure the network, gather evidence, and capture the terrorists.
This paper provides a methodology to determine, relatively rapidly, the connectivity reliability of the transportation network under threats of terrorist incidents that accounts for:

- The lack of historical or frequency information, with which to determine individual link failure probabilities under extraordinary conditions,
- The effects that attacks on other assets have on the operability of the transportation network links,
- The influence of security policies on the operational state of the transportation network links, and
- The fact that asset failures are not random under terrorism conditions.

This methodology is designed for use without specific intelligence information, but, should such information become available, it can be incorporated easily. This process contributes to advanced planning for terrorism events and evaluates the impact of security policy on the transportation network.
The methodology presented in this paper consists of four steps. The first step determines the terrorists' intent, whether to disrupt national security, inflict casualties, disrupt the target area's economy, and/or lower public morale and evaluates each asset within the network's bounds in terms of the terrorists objective(s). The second step identifies potential attack methods in terms of the terrorist's capabilities and resources, the history of similar attacks, and asset vulnerabilities to those methods. The third step determines the likelihood of transportation link damage whether by intentional targeting or as collateral damage by an attack on adjacent assets. The final step captures the effects of security policies on the operational state of the transportation links and calculates the resulting connectivity reliability.
This methodology is illustrated with a small sample network and notional data. For this particular example, the connectivity reliability is 0.999994, indicating that the decision makers associated with this particular network should not be overly concerned with connectivity of the transportation network between the origin and destination of interest under threats of terrorism and the security policies examined.
The methodology used to derive the connectivity reliability for the transportation network under threats of terrorism is somewhat subjective in the absence of specific intelligence information; however, a lack of detailed information should not preclude the analysis. Decision makers need to plan ahead and determine the potential impact that a terrorist event would have on the network as well as the effects of the security policies they choose to implement. They can also use the estimate of the connectivity reliability (bounded by zero and one) in combination with the importance of the particular origin-destination pair to determine where to best allocate resources when making additions to the transportation network.
This paper has three immediate benefits to security and reliability professionals. First, a method for determining the unreliability of a link under threats of terrorism is identified. Second, the effects of security policy actions are examined in terms of connectivity. Finally, this work offers an approach to integrate threats and security and form a comprehensive picture of their influence on network connectivity.

#39 Transferability of HCM to Asian Countries: An Exploratory Evidence From Bangkok's Multilane Highways

Piti Rotwannasin, Transportation Research Laboratory, Faculty of Engineering, Chulalongkorn University, Thailand
Kasem Choocharukul, Transportation Research Laboratory, Faculty of Engineering, Chulalongkorn University, Thailand

Synopsis

This paper aims to examine fundamental issues related to the operational quality of urban multilane traffic. A methodology is developed to investigate to what extent the current capacity analysis procedures outlined in the HCM can be applicable and transferred to urban highways in Bangkok. A number of multilane highways located in Bangkok area are selected for the present study and traffic data are collected by video cameras so that traffic movement as well as congestion could be visually observed. Several microscopic traffic flow characteristics such as vehicular speed, flow, and density are decoded and extracted by image processing unit. Based on the collected traffic data, a set of models for determining highway capacity is proposed and underlying factors that affect highway operations are identified. The proposed models are evaluated and compared against HCM in terms of predicting accuracy of highway capacity. Preliminary results show that the models developed in this study can provide more accurate means in predicting highway capacity and quality of service pertaining to Bangkok highways, and the application of the models could sufficiently serve the needs for transportation engineers. Despite an exploratory study, the findings in the present study provide a promising ground for developing a countrywide comprehensive capacity analysis manual similar to those used in the western region.

#40 Evaluation of Japanese Asphalt Binders and Asphalt Mixtures After Mixing Ground Rubber

Souza, R., Department of Civil Engineering, Chuo University, Tokyo – Japan
Himeno, K. , Associate Professor, Department of Civil Engineering, Chuo University, Tokyo – Japan

Kobayashi, A., Chief, Taisei Rotec Division Research, Taisei Rotec Corporation, Saitama – Japan

Synopsis

This paper presents an evaluation carried out for Japanese asphalt-rubber binders and asphalt-rubber mixtures. At first, ground rubber 0.2mm and 0.4mm from passenger car tires was mixed separately to straight asphalt 60/80 (grade of penetration) at rates of 0%, 9%, 12%, 15% and 18% by total asphalt-rubber weight. Conventional tests (penetration and softening point temperatures) and Superpave tests (dynamic shearing, flexural creep stiffness and apparent viscosity) evaluated the binder's properties. Ground rubber at rate of 15% mixed to asphalt produced the best behavior for both rubber sizes. Considering this, dense-graded asphalt-rubber mixtures as well as conventional mixtures were prepared. Laboratory tests performed included the Marshall Stability, flow value, residual stability, wheel tracking and static bending. Mixing ground rubber improved significantly the mechanical properties of dense-graded asphalt mixtures.

#41 Assessing Transportation Investment Priority Using Data Envelopment Analysis (DEA)

Alam, M.J.B and Sikder, S.H., Department of Civil Engineering, BUET, Dhaka-1000, Bangladesh
Goulias, K.G., Univ. of California, Santa Barbara, CA, USA

Synopsis

Transportation provides the guide way for economic activities and development. In order to pave the way of future development, huge amount of investment is being made in transportation projects all over the world. Considering scarcity of the resources required, priorities are being set on the basis of different criteria which include economic indicators like net present value (NPC), benefit cost ratio (B/C), internal rate of return (IRR) as well as other environmental and social factors. Integration of all these dimensions of decision making into a single yardstick of choice usually becomes one of the most challenging tasks for the planners. This paper presents a methodology of integrating multi-criteria decision-making framework into a single efficiency parameter by using Data Envelopment Analysis (DEA) technique. It deals with estimation of the change of regional efficiency induced by the change of accessibility caused by transportation investment. The paper also deals with measurement of accessibility on regional basis thereby capturing a broader spectrum of the investment in transportation sector.

#43 Transport System and Sustainable Development

Duchon, B. ,Department Economics and Management in Transport and Telecommunication, Czech Technical University in Prague

Synopsis

The economic transition of new states associating to European Union after the nineties brings the new approach to transport. This approach creates the unsuitable transport patterns with roads superseding railways in infrastructure and rapid growth individual transport presented by high number of cars. While in the beginning of the nineties the rate of road mode was around 30%, ten years after this number raised up to 70%. Expanding development of road transport has brought high-energy consumption, greenhouse pollution and traffic congestion.

Passenger and freight transport, both private and public, creates an important condition for the development of economic and social activities. The economic growth, competition and employment depend on the perfect functions of transportation system.

The contribution analyses the factors influencing activities of transport system: problem of energy, economic growth and financial questions of future development of transport system.

The economic and industrial development need not accompany a growth of production factors including the growth of energy consumption. Energy conservation, higher energy efficiency, fuel substitution and other activities in the construction and technology research aimed at these factors can result in lower level of energy consumption.

The further transport system development searches two approaches: the transport market with competition and entrepreneurial activities and the unique transport system, which integrates various transport modes. The aimed project of transport system with both, market and unique system approaches, creates the synergy effect of transport system. There are also discussed financial and investment problems. The contribution shows the

synthesis transport problems and integrates technical, economic and environmental elements of transport system

#44 Control of an Experimental Model for Accident Management by Means of an Investigation Carried out on the A3 Freeway prior to and after modernisation works.

Mario De Luca – Dipartimento di Pianificazione territoriale – Università della Calabria
Vincenzo Marzi – Dirigente ANAS - Responsabile dei lavori di ammodernamento dell'autostrada A3

Synopsis

In the this study a procedure is presented by which permits the construction of a model to manage the phenomenon of accidents. In particular, with the proposed model it is possible to establish the dangerousness of a road, in terms of accidents, knowing only the geometrical characteristics.
The model in question was obtained taking accident rates and other measurements connected to it, on a stretch of the A3 freeway prior to and after modernisation works. On the basis of the data captured, with the auxiliary of classical statistics and innovative operative research techniques, an expression of the model was obtained. Then, the model was applied to an unmodernised stretch of the A3 freeway and some high risk accident situations were identified, as well as the interventions which indicated the best benefit in terms of road safety.
On the same stretch, after a short period of time, modernisation works were carried out and finished in 2002. Following the aforementioned works, after about 2 years of opening to traffic, a comparison was carried out between the benefits estimated by the model and those observed following the modernisation. The result of the comparison was very positive in that the maximum error come across with the model is within 15%.

#45 Advanced numerical methods to evaluate pavements response: comparison and parametric analysis

Bruno Crisman, Department of Civil Engineering – University of Trieste
Giovanni Facchin, Department of Civil Engineering – University of Trieste

Synopsis

In the last years, the mechanistic design methods in pavements field have become increasingly widespread. This has been possible thanks to the availability of field and laboratory test equipment, the material characterization of asphalt pavements and analytical computer packages. The mechanistic (analytical) methods have two steps. The first one consists in calculating the pavement "response", that is the stresses or strains in each pavement layer for all important combinations of loading and environmental conditions. This approach is also used in the backcalculation techniques for structural evaluation. The second step consists in the prediction of the "performance" through empirical relations between response and rate of deterioration.
In the simplest case which is still widely used today, the load is assumed to be static and the material is assumed to be linear elastic. The pavement is modelled as a multilayer structure of linear elastic material subjected to a circular, uniformly distributed load. A valuable contribution to this field has been given by modelling and finite elements analysis. In this way it is possible to consider the real dynamic road loads or the load impulse of a Falling Weight Deflectometer test and mainly the realistic behaviour of a given material.
This paper is centred on the dynamic analysis with finite element modelling and with viscous elastic behaviour material. The comparison with static analysis and a complete parametric study show the relevance of this approach in the response evaluation, for both pavements design and the structural evaluation of existing pavements.

#46 TDesign of Traffic Control Systems for Commercial Vehicles in Freeways

Mahmoud Saffarzadeh , Associate Professor and Member of Piarc Committee, Tarbiat Modares University, Tehran
Hamid Reza Bahramian , Research Associate of Transportation Institute, Transportation Research Institute, Ministry of Roads & Transportation

Synopsis

Freeways are the most important routes in ground transportation network in terms of traffic volume, speed and level of service. The concept of controlling traffic in freeways includes many topics. In this study two items

including speed control and weigh in motion were chosen and Tehran- karaj corridor was selected as a case study due to its important role in transportation in the country. At first the necessity of speed and weigh controlling was investigated. Regarding to similar studies in developed countries, speed cameras and weigh in motion systems were chosen as suitable technologies for speed and weigh control in the corridor. Finally methods for finding appropriate locations for equipment installation were studied. After collecting traffic data and analyzing them, positions for placement of speed cameras and WIM technologies were determined.
Keywords: Traffic control, Commercial Vehicle, Freeways, Weigh in Motion, Speed Control

#49 Multi-Criteria Analysis to Evaluate Road Safety Measures and Allocate Available Budget
Maria Grazia Augeri, Rosario Colombrita, Agata Lo Certo, Department of Civil and Environmental Engineering - University of Catania- Italy
Salvatore Greco, Benedetto Matarazzo, Department of Economics and Quantitative Methods - University of Catania - Italy
Synopsis
A suitable road safety improvement program involves firstly the identification and investigation of sites with a high accident rate. Successively, specific countermeasures must be developed in order to reduce the number or severity of accidents of the dominant type at the location.
The aim of this research is to provide the decision maker with a decision support system for highway safety resources allocation among different hazardous sites. In fact, budget constraints impose to prioritize and select crash countermeasures taking into account different objectives and maximizing the efficiency of investment.
The principal objectives included in the analysis are the lowering the expected number of accidents of different types and severity and the minimization of the cost.
We consider also the possibility that some countermeasures can be implemented alternatively at same site, selecting then the best solution that optimize the objectives.
The considered objectives are non commensurable because accidents of different type and severity are heterogeneous among them and with respect to the related cost. Since we want to avoid to convert everything in monetary terms using some cost-benefit analysis methodology, we propose a multiobjective optimization methodology that permits to express the different objectives in their respective units.
As each considered countermeasure can be realized or not, without any possibility of realizing it partially only, our multiobjective optimization methodology considers discrete 0-1 variables (0 for “non implementation of the countermeasure”, 1 for “implementation of the countermeasure”).
The joint consideration of a multiple objective optimization and of discrete 0-1 variables is the major distinctive feature of the proposed approach in comparison with other competitive methodologies presented in literature.
A simple example is presented to illustrate the salient features of the proposed methodology.

#51 The Impact of Transport Infrastructure on Land Value Using Tyne and Wear Metro As Case Study
Du, H TORG, School of Civil Engineering and Geosciences, University of Newcastle upon Tyne
Mulley, C. TORG, School of Civil Engineering and Geosciences, University of Newcastle upon Tyne
Synopsis
In recent years, land value capture has attracted increasing attention as a result of its potential for funding transport infrastructure. However, it is crucial to examine the evidence of the impact of transport infrastructure on land value as it is increases in land value following new transport infrastructure which predicates policies of land value capture. There has been substantial research into this issue recently in the US. But, in the UK, only a few studies have considered this subject and these studies have concentrated on London. The capital is different in many aspects from other places in the UK. Other conurbations such as Manchester, Sheffield, Tyne and Wear, etc. might be more representative for British cities. Following studies on the impact of light rail transit on property prices in Manchester and Sheffield which employed hedonic models, the Tyne and Wear Metro seems to be an appropriate case to study in the UK context using new techniques.
This paper looks at the relationship between transport infrastructure and land value using Tyne and Wear Metro as a case study to examine the impact of Tyne and Wear Metro on the value of residential properties using a new methodology. Traditional techniques to understand changes in property value such as hedonic models, which use multiple regression modelling, normally assume that the observations in the regression are

independent of one another. However, the spatial autocorrelation often present within geographical data means this is unlikely to be the case. In this paper, with the accessibility information derived from the Tyne and Wear Accessibility Model and other social economic data derived from census 2001, the methodology employs a Geographically Weighted Regression model, a new approach to spatial data analysis. It works by modifying multiple regression modelling to be better suited to geographical enquiry so that property prices, in this case as the dependent variable, is then explained by a number of spatially defined factors including transport accessibility of the house location. It is hoped that the estimation of the importance of transport accessibility in determining house prices will help to identify the potential for land value capture associated with transport investment.
The results from GWR do clearly reveal a spatially varying relationship between property prices and a number of spatially defined variables. The initial results from the global regression model show that the internal factors of the property and socio-economic classification of its location are the dominant determinants of property prices while transport accessibility variables, as key components of property location reflecting land value, are significant too in determining property prices. The spatial analysis with GWR indicates that most local parameter estimates of the variables vary significantly over Tyne and Wear area. Through mapping the results of local parameter estimates from GWR, this paper concludes that public transport accessibility does affect property prices, particularly in relatively poor neighbourhoods and property value is increased in some areas as a result of being close to city centre, confirming the recent trend of gentrification following the trend of suburbanisation of the past decades.

#54 Reliability of individual points of the road
Ernesto Cavuoti, Polytechnic University of Bari
Synopsis
We propose the use of the structural engineering reliability model for evaluating the reliability of the individual points of a road infrastructure.
The specific processing for the following cases are reported:
1. Stability on curves.
2. Presence of a fixed obstacle located in the traffic stream.
3. Overtaking manoeuvre, in the hypothesis that it is not possible to return to the normal driving lane.
4. Overtaking manoeuvre without binding circumstances.
This method is essential for evaluating the ex post economic convenience of the improvements carried out on an existing road and the ex ante one for planned roads, using the data regarding similar situations.

#55 The global reliability of paths between a pair O-D
Giovanni Gatti, Politecnico di Bari
Ernesto Cavuoti, Politecnico di Bari
Synopsis
One of the possible definitions of reliability of paths between a pair O-D on a road network is given by the probability that a user could reach a destination D using his own vehicle starting from an origin O, in a given time "tBoB" considering that an ensemble of events which could delay march may occur.
The following study suggests a model for the valuation of the path reliability between two nodes O-D of a road network by starting from a given network configuration, from well-known values of volumes of traffic and well-known time frequencies of the above events.

#56 Evaluation Of Roundabout Entries Reliability
Esposito T., D.I.T. Università degli Studi di Napoli "Federico II"
Mauro R., D.I.M.S. Università degli Studi di Trento
Corradini M., D.I.M.S. Università degli Studi di Trento
Synopsis

This paper presents criteria to evaluate roundabout performance reliability. After introducing and justifying the adoption of reserve of capacity and rate of capacity as performance functions, the discussion is developed using a general calculation criterion in which the values that are involved in the limit state service condition – traffic demand and entry capacity – are random variables described by their probability density functions, that is to say by their distribution functions.
A lower level criteria is then identified with which, on the basis of the estimation of suitable statistics of the performance function, a reliability index is calculated that can be compared to a prefixed reference value.
Using a set of numerical applications performed on the basis of the adoption of some of the methods for capacity calculation that are more largely used in the technical practice, the criteria elaborated are concretely exemplified.

#57 Research for a road engineering structure surface quality indicator
Liuzzi, R., Polytechnic University of Bari
Mele, A., Polytechnic University of Bari
Synopsis
The current indicators of the condition of a road engineering structure are based on a system of visual inspections. These indicators do not take account of decay in the internal layers of the elements of the engineering structure. The paper analyses the measurements obtainable with physical parameters, determined during the course of thermographic, georadar and tomographic investigations and applied to road engineering structures.
The indicators of the parameters referred to each type of investigation may then be aggregated in a single indicator, which expresses the overall measurement carried out and allows the maintenance of the road engineering structures to be programmed.

#58 A Genetic Algorithm for Multiyear Pavement Maintenance Optimization
Gaetano Bosurgi, Dipartimento di Ingegneria Civile – Università di Messina – bosurgi@ingegneria.unime.it
Antonino D'Andrea, Dipartimento di Ingegneria Civile – Università di Messina – dandrea@ingegneria.unime.it
Franco Trifirò, Dipartimento di Ingegneria Civile – Università di Messina – francotrifiro@ingegneria.unime.it
Synopsis
An ideal pavement management is one that would maintain all pavement sections at a high level of serviceability requiring a low budget and use of resources. Unfortunately these are conflicting requirements. Then, the benefits of pavement management can't be realized if pavement management activities such as maintenance treatments and repairs aren't optimally programmed at network level over an appropriate multi-year planning period.
Due to the complexity and scale involved in the programming of activities for pavement management at the network level, conventional analytical optimization tools have not found widespread applications in practise.
Within this context, emerging technologies, such as soft computing techniques provide efficient alternatives to the traditional mathematical approaches.
In particular, genetic algorithms represent an efficacious approach to extrapolate optimal solutions within a range, even though enormous, of possible solutions in sufficiently quick time spans. In the case of road maintenance management, this technique proves to be particularly appropriate in relation to the numerous variables characteristic of the problem, to the different objectives to be reached and to the necessity to individuate the optimal allocation of the interventions.
This paper describes the development of a genetic algorithm for determining the optimal multi year pavement repair schedule. The problem of finding the best multiyear work plan can be modelled as a combinatorial optimization problem. The objective of which is to achieve the highest possible average network condition for a given budget.
The procedure was applied to a motorway infrastructure belonging to the motorway network of Eastern Sicily (Italy).

#59 Motorway and local development : experience drawn from studies conducted by the A39 motorway in France over a period of ten years : 1993-2003

Mr. Jean-François Langumier, Société des Autoroutes Paris-Rhin-Rhône – SAPRR – (France), Chef de la mission Prospective and Développement Durable Auprès de la Direction Générale – Direction de la Stratégie du Développement Durable

#60 Evaluation of the Deceleration Rate for the Operating Speed-Profile Model

Ph.D. Ing. Paolo Perco, Department of Civil Engineering, University of Trieste
Ing. Alberto Robba, Department of Civil Engineering, University of Trieste

Synopsis

The Italian Standard uses the design speed-profile to check the consistency of the horizontal alignment and to avoid dangerous changes in speed. However, the real speed used by the driver to travel a curve can differ significantly from the design speed of the same curve. Moreover, the speed reached along tangents can also differ from the maximum design speed of the road. Therefore, an operating speed-profile was proposed in order to better represent the real speed used by the driver and, consequently, to check the consistency of the alignment. This profile uses operating speed models to predict the operating speed of the geometric elements (circular curves and long tangents) as a function of their geometric characteristics. However, even though these models enable us to give a good estimation of the real speed along the single elements, there is still little information about how the driver varies the speed between successive elements. Real acceleration and deceleration rates, as well as driver behaviour between curves with different operating speeds separated by short tangents, are only presumed. Therefore, a new research using a light detection and ranging (lidar) gun was set up to improve knowledge of speed variations along the transition sections. The primary object of the research is to establish conclusively deceleration/acceleration rates, and driver speed behaviour approaching/departing from curves. The first step in the research involved the collection of a sample of speed-data to evaluate speed reduction approaching a circular curve. This subject was selected as the first step because, given the nature of curve-related accidents, accurate deceleration rates are more important in the model than acceleration rates. The speed data were collected on 10 sites composed of a curve and preceding tangent. The paper presents the preliminary results of the data analysis. Two different approaches were used to calculate the deceleration rates from the speed data and these approaches led to significantly different rates. The analysis indicates that a deceleration rate of 0,85 m/sP2P can be used in a simplified operating speed-profile, but this value represents only a rough approximation of the real deceleration rates. In fact, the deceleration rate varies along the distance travelled during the speed reduction before the curve. In particular, the data shows that in the final part of the speed reduction the deceleration rate is higher than in the first part. Moreover, the results show that the deceleration rate varies significantly between different curves. These differences could be due to many factors such as the characteristics of the curve, of the upstream alignment, of the overall road environment. The research will continue to investigate these relationships collecting additional data on new sites.

#61 Evaluation of mechanical characteristics by deflection measurement on rigid or composite pavement.

Prof. Aurelio Marchionna, University of Trieste – Department of Civil Engineering
Ing. Giulio Ossich, University of Trieste – Department of Civil Engineering

Synopsis

The utilisation of non-destructive tests done on site, in order to evaluation the mechanical characteristics of the pavement layers, is now essential for a correct maintenance of the roads. A particularly suitable and widely used instrument is the falling weight deflectometer – FWD.
The aim of this paper is to illustrate a method for interpreting deflection basin measured by tests on rigid or composite (Asphalt Concrete/Portland Cement Concrete) pavements. The proposed method is based on correlations obtained through numerical simulations by the use of two different theoretical approaches (slab on elastic solid and elastic multilayer).
This methodology is practically important because, in case of composite pavement, it is able to get the mechanical characteristics of all the layers by the deflectometer measurements only; besides this methodology don't require to determine mix composition and bitumen properties. As a result, we can eliminate for the

evaluation of asphalt concrete layer modulus the present use – AASHTO GUIDE – of a relationship with temperature layer and mix composition and bitumen properties. Therefore, this method consists in a procedure that allows us to obtain the mechanical characteristics of all the pavement layers by the use of parameters got by means of different deflectometer measurements and by the application of some simple specific equations.
In the end, the results obtained by the methodology application on a concrete case and the validity limits of this approach are illustrated.

#62 Operational And Safety Effects Of The Deceleration Lane Length

García; A, Professor, Departamento de Transportes, Universidad Politécnica de Valencia
Romero; M, Ph D Student, Departamento de Transportes, Universidad Politécnica de Valencia

Synopsis

Researchers have reported high accident rates on exit ramps with the highest percentage of accidents taking place on the deceleration lane, since these rates change according to the deceleration lane length. Longer deceleration lanes are recommended but limit the length on benefit-cost analysis. Previous experimental observations carried out by various researchers, did not correspond to the kinematic models of uniform deceleration that is usually adopted. In the construction to improve a section of the freeway CV-35, near the city of Valencia, a weaving lane was changed to an exit lane because the access had been closed. In order to study operational and safety effects of a deceleration lane as a function of its length, four configurations for the diverging lane were established, using road marking tapes. Two additional configurations were evaluated: the initial configuration to study the drivers' behavior with the original weaving lane but being used as deceleration lane since the entrance was already closed, and the final configuration adding a barrier along the edge of the taper, to test the barrier's effect. Up to now, research has been carried out in field study of the phenomenon using various deceleration lanes, with different road and traffic characteristics according to their locations. In this research, for the first time, experiments were carried out in the same place, which allow us to study vehicle behavior as a function of the length, maintaining constant the other highway characteristics as well as controlling traffic characteristics. In each configuration of the deceleration lane video recordings with four cameras were taken for tracking the vehicle evolution on leaving the main road. Later, the videos were digitized and specific software was developed to convert the information from 2D to 3D. The successive positions of the vehicles on the roadway associated to times, gave us the trajectories, speeds, decelerations and accelerations. Then, the exit phenomenon was analyzed in function to the lane length: exit trajectory types; speeds; decelerations and their localization. A detailed study of the potentially dangerous maneuvers was also carried out, not only in the studied configurations, but also in other two deceleration lanes. A very interested conclusion has been obtained: the shorter and the longer lane length, the less safety. The optimal lengths are intermediate.

#63 Roads And Regional Integration In Spain

José María Díaz y Pérez de la Lastra, E.T.S. de Ingenieros de Caminos, Canales y Puertos de Santander (Santander Faculty of Civil Engineering) University of Cantabria, Spain
Alberto Domínguez Sarabia, University of Cantabria

Synopsis

One of the reasons why transport facilities are developed is territorial integration across regions in a country and across Member States within the European Community. It is becoming increasingly common for infrastructure plans to cite territorial integration as one of their aims, with a view to securing adequate transport networks as a means of accessing and connecting the various regions with other areas and with their own internal districts, thus boosting their economic potential.
On the present approach to regional integration, regions seek to enhance their economic prospects by reinforcing their own capabilities so as better to mesh with an increasingly competitive and fast-changing environment. Against this background, measures must be taken to encourage trade, transport infrastructure (which for a long time has been inadequate) and industrialisation in the regions.
This paper examines the relationship between road infrastructure and regional integration in Spain and looks at hypothetical cause-and-effect relations. The research on which this paper is based compares and contrasts the behaviour of demand for road transport of freight (intra-regional and inter-regional), road transport infrastructure

and wealth generated in the fifteen mainland Autonomous Communities (self-ruling regions) of Spain. The study covers the period 1995-2003. The period is sufficient to examine the various Spanish territories on both an individual and on a comparative basis.
The conclusions of the paper will clearly show that the economic development of the regions directly affects one of the key aspects of regional integration: the exchange of freight. Further, we shall assert that over the course of recent years, a few notable instances excepted, inter-regional differences in road usage have lessened.

#64 Modelling Goods Transport In Spanish Autonomous Communities

Domínguez Sarabia, A., Civil Eng. - Investigator, Department of Transport, University of Cantabria, Spain
Díaz y Pérez de la Lastra, J.M., Head Professor - Investigator, Department of Transport, University of Cantabria, Spain

Synopsis

Although a significant development has taken place over recent years in demand models in the sector of passenger transport, the same cannot be said for demand models for freight transport in spite of the only difference between them being, from a conceptual perspective and that of global demand models, the actual meaning of the variables that characterise the flow of passengers or freight.
The objective of the present paper is to show the results of an investigation in which various models were assimilated to establish a series of relations between infrastructural facilities, freight traffic and diverse socio-economic factors, mainly family income and GDP. Obviously, given that the territorial area and the time range of the study has to be defined for the configuration of such models, two different lines of investigation were established:
The scope of study of the first line of investigation is the group of autonomous communities in mainland Spain. In order to carry this out the data referred to above had to be compiled for each of the autonomous communities (infrastructural offer, freight traffic and socio-economic factors) for 2001; i.e. over a specific year, the variable is the geographic location.
The scope of study of the second line of investigation is the analysis of two autonomous communities with different socio-economic conditions, in this case Andalusia and Catalonia. For each of these, the aforementioned relations were established based on a study period between 1996 and 2001. In this case, the autonomous communities were determined and the different relations over this period of time were studied by using a series of historical data.
The first of these investigation lines, the autonomous approach, allowed obtaining a function which correlates freight traffic and the provision of infrastructures. Of all the socio-economic variables analysed, those which best show such a correlation are the total amount of moved freight (expressed in tons-kilometre) and the kilometres of high-capacity road existing for each of the autonomous communities. The investigation continued to evolve in order to try to find various indexes that combine with the group of transport infrastructures and that relate it with this freight traffic.
The second of these investigation lines, the time approach, allowed analysing the evolution of freight traffic over a period of time. The correlation functions obtained allowed analysing the elasticity of the demand (the total amount of freight moved) with regard to the GDP (which is considered as the most representative socio-economic variable). The greater or lesser value of the function exponent allowed verifying the lesser or greater level of development of each of the autonomous communities analysed.
By analysing the results, we hope to reach conclusions which lead to establishing criteria for the planning of infrastructural facilities with operative indications for the areas examined.

#65 Driver Perception of Crest and Sag Combinations at the Driving Simulator: effects on driver's behaviour

Francesco Bella, Department of Sciences of Civil Engineering - Roma TRE University

Synopsis

Several researches have pointed out that optical illusions may occur when the horizontal curve is combined with a vertical curve. Crest and sag combinations can cause a significant different driver's behaviour compared to the behaviour adopted on the horizontal curves on flat grade. In particular the literature reports the hypothesis that

horizontal curves appear sharper or flatter when overlapping with crest o sag vertical curves, respectively. This hypothesis was validated from studies on the visual perception of the road through the use of computer animation techniques. On the basis of these researches models were proposed to estimate the horizontal radius perceived on the combined curve as a function of the actual horizontal radius to evaluate the operating speed through 2-D predicting models.
A drawback of computer animation techniques though is that they are limited and not interactive. Interactive driving simulation systems, on the contrary, have high potentials for the analysis of the effects of the combined alignment.
An experimental survey at the driving simulator of CRISS (Interuniversitary Research Center on Road Safety) was carried out in order to assess the driver's behaviour on crest and sag combinations, compared to the behaviour on horizontal curve with the same radius but on flat grade. Two road alignments for the experiment were designed according to the technical Italian guidelines on the coordination of horizontal curves overlapping with vertical curves. One alignment had a flat longitudinal grade, the other had three crest combinations and three sag combinations but with the same horizontal alignment. The vertical grade on the approach tangent of each combined curve was flat in order to avoid the influence of the grade on driver's behaviour. 35 drivers carried out two driving sessions at the simulator (one for each road alignment) during which the local speeds and the local lateral placement were recorded.
On the crest combinations the result of statistical analysis of the speeds was entirely consistent with the hypothesis of perception on crest combinations: at beginning of the circular curve on the reference curves the speeds are greater than those on the correspondent crest combinations. Furthermore the outcomes of the unilateral Z-test showed that the differences between the speeds on reference curves and those on crest combinations tend to decrease as the curve radius increases. Also the influence of the crest vertical curve on the trajectory was clear: the mean deviations from the ideal trajectory at the beginning of the circular curve with radii medium and great were significantly higher on the crest combinations than the mean deviations recorded on the reference curves.
On the sag combinations the speeds were not significantly higher (at 5% significance level) than those on the correspondent reference curves. Such result does not seem to strengthen the hypothesis of perception on sag combinations and suggests that the models to estimate the horizontal radius perceived on the sag combinations as a function of the actual horizontal radius to evaluate the operating speed through 2-D predicting models are inappropriate. No significant effect of the sag vertical curve was observed on the trajectory.

#66 Modeling and Simulation of Physical Mobility within the Nexus Framework

Florian Bitzer, Bruno Arbter, Wolfram Ressel, Institute for Road and Transportation Science, University of Stuttgart, Germany

Synopsis

The Nexus framework anticipates the influence of the general computational development towards the so-called state of Ubiquitous Computing, where not only most electronic devices but even those objects which today have no electric supply will be aware of their position and context and be able to communicate among each other. This will be a kind of a by-product of the ongoing miniaturization of electronic components, growing performance of processors and memory and at the same time dropping prices. By using this communication capability and the collected spatial information, the Nexus framework will provide a platform for multiple spatial aware services for mobile people and self organizing applications.
For making mobile objects spatial aware, numerous sensors are needed, which can be placed on the object itself as well as in the stationary environment. In addition, simulation of physical mobility helps to bridge the lack of spatial sensor data or in a first phase generates virtual sensor data for test purposes for Nexus components and applications.
The simulation and modeling research in our subproject focuses on two aspects of user mobility: the mobility of pedestrians and the mobility of motor-driven vehicles. As for our proposal to the SIIV Congress, we want to place emphasis on aspects of microscopic simulation of pedestrian mobility.
As it is one of the most important objectives of the Nexus project, our main concern in the field of pedestrian simulation is the scalability of our modeling methods to large areas, e.g. to large (pedestrian) networks. Therefore we mainly focus on two dimensional cellular automata. By this way, we can reduce long range effects

in a complex simulation environment to a relatively small calculation rule set. We are integrating several, partly already well known approaches to pedestrian simulation based on cellular automata into a comprehensive simulation platform. This allows us to reproduce phenomena like lane formation, crossing behavior, oscillations at doors and even panic situations.
We are testing our simulation platform on a rather complex geometric environment (the campus of the University of Stuttgart), which comprises indoor, as well as outdoor situations. Because of the need of more precise geometric data, we are also developing an interface for the exchange between CAD and GIS formats and the spatial world model format of Nexus.
Up to now, there are unfortunately no satisfying ways of evaluating the quality of microscopic pedestrian simulations. The most frequently used method is a heuristic comparison between the visualization of the simulation and the reality. For that reason, a comprehensive microscopic census of pedestrian mobility within the campus area, comprising video analysis and detailed counts will be carried out in the first half of 2005. As for the SIIV Congress, we will present first results of the evaluation through real pedestrian mobility data of our microscopic pedestrian simulations based on cellular automata.

#67 Crisis Management of Highway Network under Earthquake Environment

Hiroshi Wakabayashi, Meijo University, Japan

Synopsis

This paper presents the comparative study for improving connectivity reliability between using probability importance (Birnbaum's structural importance) and criticality importance based on the reliability graph theory, i.e. connectivity reliability:
It is important to keep highway network highly reliable for both normal and abnormal period. Network reliability can be improved effectively by improving the most important key link on the network. When such important link is once discovered, it enables to improve and maintain network reliability efficiently. For the indicator for discovering the key link, Birnbaum's structural importance has been proposed so far. In series connected network, the least reliable link is chosen as the first priority link that should be improved and this result is rational as the practical and actual case. In parallel connected network, however, the most reliable link is chosen as the candidate link that should be improved, but this result is irrational, because under this decision making principle, the most reliable link would be improved more and more, and the less reliable link would never be improved. This paper presents these characteristics of Birnbaum's structural importance after discussion of the significances of crisis management of transportation systems after disaster. Then this article proposes the Criticality importance as the better indicator and compares the network performances improved by both importance indicators. In addition, this paper addresses the criticality importance can consider the fact that it is more difficult to improve the more reliable links than to improve the less reliable links. After these characteristics of two indicators are discussed using series and parallel network, a numerical examples are demonstrated. In this example, the link reliability is assumed to be a function of link flow. Stepwise improvement of link reliability based on the Birnbaum's structural importance or Criticality importance is executed using link cost method. The reliability between two nodes as the consequence of link reliability improvement is calculated. The network improvements based on Birnbaum's structural importance and Criticality importance are compared. The evaluation indices are node-to-node reliability and total travel time. The result is that the network improvement based on Criticality importance is better than that on Birnbaum's structural importance both in node-to-node reliability and total travel time.

#68 The Role Of Pavement Permeability And Satellite Tracking In Abating Risks In Hazmat Road Transportation

Praticò Filippo G., DIMET Department Of Computer Science Mathematics Electronics And Transportation, Reggio Calabria Mediterranean University
Ammendola Rachele, DIMET Department Of Computer Science Mathematics Electronics And Transportation, Reggio Calabria Mediterranean University

Synopsis

As is well known, about 1520%

of road freight transports in Europe concern hazmat (hazardous materials).
In particular, in Italy there are about 10 9 Kilometres per year of hazmat road transports; about the 93.7% of hazmat transports choose road vehicles.
Given that, it becomes more and more important to formalize methods and to design devices in order to validate the effectiveness of techniques and infrastructures in reducing hazmat risks.
Pavement contribute to abate risk is herein considered in terms of Hot Mix Asphalts (HMA) outflow times.
In order to evaluate the influence of the quality and quantity of the fluid that get off the vehicle, a specific device was designed and constructed by the Authors at the DIMET laboratory (DIMET Department at the Mediterranean University of Reggio Calabria). The use of the new device followed the formalization of a suitable experimental procedure.
Weather influence on the process was also considered.
Satellite tracking by the new satellite system GALILEO was analyzed as a strategy to contribute to decrease hazmat risks. So, in the formalized model, Authors tried to quantify both probability and magnitude consequences.
The practical applications of this work can be divided into two main sets: a) analyze how much a new European satellite network could be useful in reducing hazmat risks in road transportations; b) designing and assessing a procedure (by an apt device) to estimate how much a transported fluid can be dangerous for the environment near/below the road.

#69 Time-Dependent Surface Properties Of Asphalt Friction Courses: Earlier Experiments By A New Accelerated Test

Boscaino Gabriele , DIIV Department Of Road Infrastructures Engineering, Palermo University
Praticò Filippo.G., Associate Professor, DIMET Department Of Computer Science Mathematics Electronics And Transportation, Reggio Calabria Mediterranean University
Vaiana Rosolino, Researcher, DIPITER Department Of Territorial Planning, University of Calabria-Arcavacata Campus (Cosenza)

Synopsis

Pavement Management Systems need to estimate schedule and costs; as a result, it becomes more and more important the evaluation of friction and texture reduction in time for different conditions of traffic and weather. This can be done by suitable provisional models in order to analyse factors affecting wearing and their influence on surface performance.
Full-scale experiments (often consistent and effective but expensive) or accelerated friction testing (often reliable, less expensive, with well-controlled boundary conditions) are so needed.
This paper deals with the design and the carrying out of an experimental plan in order to realize low-cost information on friction and texture decrease as an effect of traffic.
An apposite device has been recently designed and constructed at the DIIV Laboratory (Palermo University - Department of Road Infrastructures), by modifying a Wheel Track Machine for rutting tests.
Authors present the results of the earlier experiments on friction reduction; time-friction and time-texture curves are analysed and interpreted. Friction is estimated in terms of British Pendulum Number while both micro- and macro-texture components are measured by a laser device.

#70 Experimental And Theoretical Investigation On Hot Mix Asphalts Outflow Times: Boundary Conditions Influence

Praticò Filippo G., DIMET Department Of Computer Science Mathematics Electronics And Transportation, Reggio Calabria Mediterranean University
Moro A. DIMET Department Of Computer Science Mathematics Electronics And Transportation, Reggio Calabria Mediterranean University

Synopsis

The goal of this paper is confined to the permeability and drainability of Hot Mix Asphalts (HMA), as key-characteristics for pavement reliability. As is well known, these parameters may be considered very important in

assessing both surface performance (wet friction, splash and spray, raveling, stripping, etc.) and mechanistic properties (resistance and moduli dependence on water action).
Authors formalize a physical-based model to analyze the phenomena of water flows for different typologies of friction courses (Dense Friction Courses, Open Graded Friction Courses, Porous Asphalts, etc.).
On the basis of the formalized models, a specific experimental plan was designed and performed, in order to analyze the relationships among the main parameters of the model.
Boundary conditions influence on outputs was deeply investigated, by considering different methods in obtaining outflow times.
The focal applications of the study, both theoretical and experimental, are the following two: a) assessment of a relation between composition and drainability; b) estimation of the relative influence of some boundary conditions.

#72 Function of the Vegetation Along Designed Line Route
Myšková Jana, Kočárková Dagmar, Czech Technical University, Faculty of Transportation Sciences, Department of Transportation Systems, Konviktská 20, Prague
Synopsis
The main aim was to find out any realitonships between the vegetations along the route and eliminations of the traffic noise. Other part of the report observes impact of the vegetation season to eliminate the noise by greens. Compares measuring of the noise during a winter season (plants are without any leaves) and during a spring or summer season - vegetation season (plants are with leaves). Species of the plants used for noise eliminate were examinated simultaneously.

#73 Reliable design and evaluation method for multilane signalised intersections
Francesco Viti, Delft University of Technology, Delft, The Netherlands
Henk J. van Zuylen, Delft University of Technology, Delft, The Netherlands
Synopsis
Signal controls are designed for increasing safety and regulating conflicting flows. On the other hand they may highly reduce road capacities if not properly set. It is always a challenge for the road authority to find the best design, both from the operational and from the infrastructural point of view. From both sides a good estimation of the traffic to be served and the network costs is needed.
Good design of the road geometry at signalized intersections helps at better managing the different streams approaching the intersection, avoiding conflicts between flows diverging to different directions. Often in practice accumulation lanes are constrained to be smaller than required for spatial reasons, especially in urban areas. In other cases the error comes from bad design of the intersection.
The Highway Capacity Manual (HCM) provides analytical formulae for computing the mean value of the queue but does not give any suggestion on how variable this value can be. An underestimation of how many vehicles to be served at an intersection can raise several problems, i.e. spillback with consequent increase of waiting times and lane blocking together with serious decrease of safety. Cars may not be served within a green phase because blocked by a spillback of another lane; moreover they can try risky maneuvers to be served and increase the chance of accidents.
This paper proposes a probabilistic method based on the Markov chain renewal process, especially suited for practitioners, to compute the dynamics of queues and their variability to design and evaluate the optimal length of accumulation lanes with particular regard to spillback avoidance. The method allows the analyst to estimate the control delay for an individual vehicle in time and the uncertainty of this delay to occur.
We propose also a heuristic model, which computes the average and the standard deviation of queues in time for variable demand and variable signal settings. The model has been implemented in a test scenario and compared with the Markov Chain simulation results. To assess the consequence of spillback we also compute the queue dynamics in a multilane and multiphase signalized intersection, showing how the queue on a restricted turning lane can influence the formation of queues and the behavior of users on the other lanes.
The model is shown to fit better simulation data generated with Markov Chain processes than the HCM especially when the intersection is slightly under- or oversaturated. Simulation data suggests assuming in a

design and evaluation study for accumulation lanes a queue distributed as Normal constrained to be non-negative. A risk-averse road administrator can then set a certain probability threshold and compute the maximum amount of passenger car units an accumulation lane needs to be designed for. This method is expected to better estimate this length than using the HCM especially when a responsive control signal is implemented.

#76 Lightweight Highway Embankments to solve the "Underground Dam Effect"

Maltinti F. DIT – University Of Cagliari

Synopsis

In previous studies, the author highlighted the way in which the construction of a road embankment can modify the stress state of supporting ground, its permeability and hence groundwater level, causing the "underground dam effect", in particular circumstances.
A model has been developed to determine ground stress state and, to analyse it, a finite element method has been used with the support of ANSYS® software. The model has been parameterized for ground slope, embankment size width, half roadway size and slope size width and, finally, for embankment height. The software has provided horizontal and vertical stress distribution. Void index has been determined through the compressibility curve and also the permeability for each element. Subsequently, the groundwater level trend was reconstructed after fixing the flow and forward groundwater depth.
Various cases have been examined: changing ground characteristics, embankment height, ground slope and finally changing groundwater depth, and critical situations have been identified.
In this study the author shows the way in which the utilization of expanded clay or geofoam applications in highway embankments could solve the "underground dam effect" and hence allow infrastructure insertion in the territory causing minimum hydrologic impact.
Indeed, infrastructure design must target durability during useful life, preserving land balance and guaranteeing preservation of the environmental conditions existing before road construction

#77 Development and investments in the road sector. A methodological approach to determine the correlation between these variables

Emanuela Cecere, Department of Territorial Engineering, University of Cagliari - Italy
Francesco Annunziata, Department of Territorial Engineering, University of Cagliari - Italy

Synopsis

The augmented generalisation of mobility and the necessity for the creation of interconnection systems is an argument in favour of investments in transport infrastructures. It thus appears necessary to determine the level and destination of investments to improve the economy and infrastructures system in its entirety. Investments in transport infrastructures produce a circular process.
They produce an impact on a nation's development, as well as on its economic structure and productive activities and thus increase mobility, which in turn leads to the need for new investments in infrastructures.
The relationship between infrastructure and development thus appears to be biunique. Many studies have shown that there is not always a correspondence between infrastructures and economic development.
The main purpose of this work is to evaluate the increase in mobility with respect to development and to establish if and how expenditures in the road sector influence the demand for mobility. A further consideration is how such expenditures influence economic development.
This paper describes functional ties between increases in mobility and expenditures in the road construction sector. Macroeconomic variables influencing, or related to private passenger, road network extension, number of vehicles per person and, GDP were first identified.
Secondly, the possible relationship between the variables were analysed. Cointegration, which was developed by Johansen in 1988-1990, was the procedure used to find the relationship between the different variables. It studies both short- and long-term relationships between the variables of the system. Time series were reproduced for the variables, capital outlay and current outlays for road infrastructures and transport. Cointegration was applied after standard tests on the stationariness of time series had been performed. All this

aimed at evaluating the influence and possible time-spread between the overall development of national wealth and the ensuing demand for mobility and between investments and mobility.
The final objective of this research work was the formulation of analytical functions capable of describing the phenomenon. Also a series of social and economic time variables were verified, e.g. how mobility is influenced or can exert an influence on the general pattern of development.

#78 The influence of cellulosic fibres on the performances of draining bituminous mixtures
Massimo Pisciotta, Department of Highways and Transportation - Politecnico di Bari
Synopsis
The following research provides the results of the experiment carried out on draining bituminous mixtures, to which stabilizing micro-fibres of pure cellulose in compressed granules have been added.
Several samples of draining mixtures with and without the addition of fibres have been subjected to the Marshall Test and to the Indirect Tension Strength Test.
The coefficient of permeability K has been determined for all the tests.
The experimental results have proven that in an open mixture the fibres act as a support for the binder, improving the mechanical characteristics and increasing the ductility of the material.
Moreover, the increase in the coefficient of permeability K improves the draining function of the mixtures with added fibres.

#79 A Cumulative Prospect Theory Approach to Traveller Behaviour Prediction
Dino Borri, Dipartimento di Architettura e Urbanistica, Politecnico di Bari
Giovanni Circella, Dipartimento di Vie e Trasporti, Politecnico di Bari
Synopsis
Transport systems in Urban Areas are day by day becoming more complex. The rising complexity of these systems, combined with the congestion of most European city centres, creates not easily predictable choice behaviour of travellers. Frequently, transport system users are required to deal with a great variability of the alternative attributes; travellers' choices are consequently influenced. Even greater is the influence this variability has on commuters.
Several approaches has been developed to predict travel choice behaviour. Nowadays, most part of them are still based on the hypotheses of the Random Utility Theory; despite that, the observation of real choices among transportation system users highlights a non-linear choice behaviour, which is not possible to explain with Random Utility Models. Thus, more powerful tools are required by planners to evaluate choice behaviours of travellers, to guide the design of new transport infrastructures and services. With this aim, some other choice models, based, e.g., on Fuzzy Inference, have been developed.
In this work, we discuss the opportunities offered in this field by Kahneman & Tversky's Cumulative Prospect Theory. This theory, especially designed to predict choice behaviours in conditions of uncertainty and risk, was first applied to monetary choice problems, such as lotteries with money prizes; more recently, it has been also applied to other research fields. At the moment, few experiences are reported on the application of the theory in transportation planning: Prospect Theory Approaches have sometimes been proposed to forecast travel choice behaviour in those choice contexts that involve high variability, uncertainty and risk. The aim of this work is to analyse how Cumulative Prospect Theory may be useful in the understanding of the way travellers behave in daily choice processes. For this purpose, a literature review of past experiments is provided. Furthermore, we report the results of an application of CPT to set up a choice model for the prediction of traveller behaviour in a medium size city. Unlike previous experiences in this field (Avineri et al.), the proposed methodology enables us to implement a modelization of Prospect Theory for the prediction of people choice based on the analysis of more than one attribute of the alternatives. The effects of the variability of the alternative attributes on travellers' behaviour are investigated in connection with the analysis of the transport system of the city of Bari. The research focuses on the effect of congestion on travel choices between different public transport lines: how congestion influences the use of the lines? The different paths followed by the lines are examined in relation to the effects of traffic conditions; travellers are seen to behave in a risk adverse way, trying to avoid risks of

delays. A detailed analysis on the way local conditions affect choices is made, with reference to the dependence of choices on past habits of the commuters (reference point from which the choice is made).

#80 Principal Component Analysis Applied to Crash Data on Multilane Roads.

Caliendo, C., Department of Civil Engineering, University of Salerno
Parisi, A., Department of Civil Engineering, University of Salerno

Synopsis

During the last few years, a lot of road-accident-predictive models have been developed by using Multiple Linear Regression and Poisson or Negative Binomial Distribution. More innovative methodologies based on fuzzy logic and neural networks have also been used. The application of these methodologies is not easy when a large number of variables is considered. Moreover, the influence of some variables on road accidents might not be equally significant. It would thus appears useful to have an analysis tool primarily in order to remove the redundant variables for accident-predictive models. Even if under-used in crash data, Principal Component Analysis (PCA) may be suitable for this purpose. PCA is a form of analysis used for extracting a reduced number of factors, called principal components, from a set of original variables, discarding as little of the information as possible.
Our objective is to verify PCA potentiality for removing redundant variables in accident analysis. For this purpose a five-year monitoring period was carried out on a four-lane median divided road. A database was subsequently created with the surveys regarding the type and number of accidents, traffic flow, horizontal and vertical alignment, sight distances and pavement surface characteristics. PCA was applied to homogeneous sections having constant horizontal curvature, separated into tangents and curves. By means of the correlation matrix the results indicate that the number of accidents on curves increases with the length (L) of the homogeneous sections, the curvature radius (1/R), the average daily traffic (TGM) and the design speed change (ΔV) between tangents and curves; whereas there is a negative correlation between these crashes and the longitudinal slope (i%), the sight distance (vis) and the pavement friction defined in terms of CAT (Side Friction Coefficient measured by means of a SCRIM equipment). Thus the results obtained prove the knowledges about this subject. Six principal components were found to account for about 90% of the variance in the original eight variables. The multiple correlation coefficient (ρP2P) between the original variables and the principal axes shows that the least significant variable is ΔV. In keeping with the literature, the correlation matrix for tangents indicates that road accidents are positively correlated to the length of the homogeneous sections (L) and the average daily traffic (TGM), and negatively correlated to the pavement friction (CAT) and the longitudinal slope (i%). Four principal components were found to account for over 90% of the variance in the original five variables. The multiple correlation coefficient for tangents (ρP2P) shows that the variables examined are all equally significant.

#82 An Evaluation of the Springbox test for Unbound Materials

Coni M., University of Cagliari, Department of Land Engineering
Thom N.H., University of Nottingham, School of Civil Engineering
Isola R., University of Nottingham, School of Civil Engineering
Edwards J.P., Scott Wilson Pavement Engineering, Nottingham

Synopsis

The Springbox is a relatively new piece of equipment, designed to generate realistic values of modulus for use in pavement design. The specimen, which can be of soil, granular or lightly stabilized material, is a 17cm cube, confined by steel sides, two of which are spring-loaded and free to move during the test. Repeated load is applied vertically through a full-face loading plate. Detailed descriptions are given elsewhere, but this paper will include an overview of the equipment. However, the principal content of the paper concerns an evaluation of the true meaning of the test based both on comparisons between Springbox data and on finite element analysis (FE) of the stress conditions within the specimen. The comparative test data are obtained on three different granular materials (Clay soil, Sub-Base and Cement Treated Base). The FE analysis was performed using experimentally obtained values of resilient modulus and Poisson's ratio and comparing the simulation with the real test in terms of longitudinal and vertical strain in order to assess the FE model. Reference is then made to the FE analysis of the equipment in order to explain the material's local behaviour inside the specimen with respect to the global

mechanical behaviour, which is evaluated during the test by means of point measurements, which are, therefore, assumed to be representative of the stress and deformation state of the material. The model is able to take into account the effect of friction between the steel sides and the material (cf = 0.4), which can highly affect the interpretation of results. Moreover, a FE parametric study was carried out under different static and dynamic load conditions on unbound materials with different characteristics. Finally, conclusions are drawn regarding the potential use of the equipment in generating values of stiffness modulus for design.

#83 Modeling e-Logistics For Urban B2C In Europe

Dante Galván, National University of Buenos Aires Center Province - Argentine
Francesc Robusté, Miquel Estrada, Magín Campos, Center for Innovation in Transport (CENIT) – Barcelona - Spain

Synopsis

Major cities need to carry out good delivery operations that coexist with the rest of urban functions. The efficiency in city organisation depends directly on the proper management of logistic networks. In this context, Urban Logistics is born to improve the efficiency in public facilities dealing with the organisation of supply networks, especially in urban freight transport networks.
This paper quantitatively models supply chains in the vehicle routing problem with time windows, especially in the delivery of e-commerce companies. Orders are placed through internet, but deliveries are made at the customer's home. The model takes special account of the effect produced on logistics variables (distances, times, costs, shipments, stops, etc.), by the way in which orders are received, and includes the delivery in time windows in urban areas.
Planners should design parking space and loading/unloading procedures so that the deliveries are made efficiently and with little traffic perturbation, and the industry should start getting ready to understand the high cost of this quality of service: the "picking" process has a high cost that cannot be assumed in high volumes and everyday the good (the street is contemplated as a scarce social good) and bad (double parking, bus lane blocking, etc. causing additional traffic congestion) use of the streets will likely cost more money. An application to Barcelona, Spain, for the food distribution sector (supermarkets) shows that, for the previously stated reasons, the current industry procedures are only feasible for very low demand share (less than 10%).

#85 The difference between the "ASTM approach" and the new "AASTHO approach" for Dynamic (Complex) Modulus

Antonio Montepara, University of Parma - Department of Civil and Environmental Engineering and Architecture
Arianna Costa, University of Parma - Department of Civil and Environmental Engineering and Architecture
Gabriele Tebaldi, University of Parma - Department of Civil and Environmental Engineering and Architecture

Synopsis

The reliability of asphalt pavement design is based on a correct characterization of the material performance.
Particularly, the insight of stress strain curves and dynamic modulus of hot mix asphalt (HMA) is significant for an accurate road pavement design by means of rational computing methods.
This research investigates the differences between two different approaches for determining Dynamic (Complex) Modulus: the A.S.T.M. and the AASHTO methods.
The first uses the A.S.T.M. D 3497-79 testing: this test has been mostly used in the past and is still very common for dynamic modulus analyses.
Master curves of HMA dynamic modulus have been drawn by A.S.T.M. test data collection using the time-temperature superposition principle, which describes viscoelastic behavior of asphalt binders. Moreover the polynomial fitting function has been used for drawing a master curve that fashions a linear trend. Unfortunately, observing HMA physical performances, it shows a non-linear behavior between low and high temperatures. A big difference has been measured between values of complex modulus recordered during the test at a fixed temperature and the complex modulus calculated with master curve at the same temperature.
The second approach for Dynamic (Complex) Modulus followed the proposal of AASTHO specification; according to this method the master curve for asphalt mixtures was developed at the University of Meryland. The

curves were drawn fitting a sigmoidal function to the measured compressive dynamic modulus tests data using non-linear least squares regression.
Moreover the research analyzed both the A.S.T.M. D 3497-79 and the AASTHO tests; according to the first test, at each temperature, the machine applies to the specimens the same load. At different temperatures the same load causes in the asphalt material a different stress level. On the contrast, in the AASTHO test, at each temperature, the machine applies to the specimens a different load but the same stress level.
In the research it has been possible to validate the AASTHO approach analysing two different materials. This approach shows the real physical behavior of HMA, while the comparison between the ASTM and AASTHO approach allows to quantify the differences between the two methods.

#86 Evaluation of aggregate size-dependent of asphalt mixtures in cracking behavior

BirgissonP PB.P, Department of Civil & Coastal Engineering, University of Florida
Montepara A., Department of Civil and Environmental Engineering and Architecture, University of Parma, Italy.
Napier J., Department of Applied Mathematics, University of Witzwatersrand, Johannesburg, South Africa.
Romeo E., Department of Civil and Environmental Engineering and Architecture, University of Parma, Italy.
Tebaldi G., Department of Civil and Environmental Engineering and Architecture, University of Parma, Italy.

Synopsis

This paper focuses on the evaluation of aggregate size effect in the cracking behaviour of asphalt mixtures. The research was undertaken using both experimental and numerical approaches; actually experimental results were fundamental to an optimize improvement of numerical analysis in order to evaluate in details the aggregate size dependent of mixtures in the cracking behaviour. The experimental section based on Indirect Tensile Tests (IDT) and Semi-Circular bending tests (SCB) performed on different fine-graded mixtures bounded with the same mastic. The numerical investigation based on the use of a displacement discontinuity boundary element method (DDM) modelling the specimens by means of a 2-D version of the program DIGS (Discontinuity Interaction and Growth Simulation) which patterns the micromechanical structure of the mixture using Voronoi tessellations.
Experimental stress-strain curves were obtained monitoring strain measurements using strain gauges of different lengths placed on the more stressed zone of specimen surfaces. The comparison between mixtures behaviour showed a very little change in the tensile strength which belongs in the error range of test procedures. The numerical analysis was performed on mixtures composed by 4-mm to 12-mm nominal maximum aggregate size. The results were consistent with the expectations: the predicted stress-strain curves showed a similar general behaviour, the ultimate strength and the softening slope measured almost the same. This implies that the characteristic performances of mixtures are strictly dependent on other parameters, as the mastic composition and the air void percent. Besides, test simulations showed a visible size aggregate dependent in crack propagations: the presence of smaller sized aggregates creates strong discontinuities and developments of many micro-cracks; this can be observed even in the softening behaviour which evolves in a constant way.
The research program showed the potential of the DDM to characterize asphalt mixtures properties and to study crack growth and propagation in dependence of different parameters. The big benefit of the numerical analysis consists in a simple and rapid investigation without incoming in faults during experimental procedures.

#87 A bilevel programming model to optimising the modal distribution of charge in urban environments with congestion: the case of the new port of Laredo.

Jose Luis Moura, Group of Research of Systems of Transport (GIST) - University of Cantabria.
Angel Ibeas, Group of Research of Systems of Transport (GIST) - University of Cantabria.
Luigi Dell'Olio, Department of Civil Engineering, University of Burgos.
Luis De Grange, Fernández y De Cea Ingenieros Ltda.

Synopsis

In this paper a bilevel programming model is presented for the resolution of the modal distribution in the charge provisioning of construction works in urban environments. The model is applied to the construction of the new port of Laredo where the modal distribution is optimized between trucks and barges, for different periods.
The used methodology is based on the minimization of the total cost of the system that is composed by the cost of the operators of trucks, cost of the operators of barges and the cost of the drivers. The drivers will be

increased their level of costs as consequence of the rising congestion induced by the flow of trucks circulating on the network.
Therefore, we solved a problem of bilevel optimization, in which the upper-level corresponds to the total cost of the system, conformed by the three agents: operators of trucks, operators of barges and drivers, and in the lower-level it is considered a users equilibrium model (cars) that responds to the first principle of Wardrop (transformed of Beckman). The problem consists on determining the optimized frequency of trucks and of barges, in such a way that the total costs of the system are minimized.
Additionally, environmental constrains are considered, as for the example the maximum level of flow in the links of the net, assuring that the flow of more trucks the flow of automobiles in the links is not superior to the critical value of flow, in reference to emission of pollutants. This way, 4 atmospheric pollutants and the levels of noise are analyzed.

#88 A model of urban public transport system design
Luigi dell'Olio, Universidad de Burgos
Luis De Grange, Fernández and De Cea Ingenieros Ltda.
Jose Luis Moura, Universidad de Cantabria
Hernan Gonzalo, Universidad de Burgos
Angel Ibeas, Universidad de Cantabria
Synopsis
This paper exposes a model of bus-stop location and frequency optimization in land public transport.
The aim of the problem-solving project is to minimize the total social cost involved in the operation of the transport system, including the costs of the provision of services (incurred by the operators), the travel costs (incurred by the users of the system) and the external costs incurred by the users of other transport means (as for example, car users) as well as the cost derived from the construction of stops.
The Optimization Problem is approached as a bi-level-type problem of full mathematical programming. We are defining a total cost function of the system which must be minimized, subject to technological restrictions, at the upper level, while at the lower level, a behaviour model for the system users is defined. Route choice on road network is made by private transport users according to Wardrop's first principle, in an attempt to minimize individual costs. As far as public transport users are concerned, it is also assumed that they choose the route which minimizes their total individual travel costs on the service network.
Given the difficulties that exist in finding a unique solution to this problem, a heuristic algorithm is proposed in order to provide adequate solutions, without necessarily guaranteeing the uniqueness of those solutions.

#89 Road Safety in Intersections Regulated by Roundabouts.
Hernán Gonzalo Orden, Civil Engineering Dept., Polytechnical School of the University of Burgos
Ángel Vega Zamanillo, Department of Transportation and Process and Project Technology Dept., Civil Engineering School of the University of Santander
Synopsis
Road safety in the different elements of an infrastructure can be analyzed by the road safety audits. From the 90's, its use in different countries has proved its usefulness.
In this paper, it is shown a summary of the most important aspects that have to be controlled in a roundabout as regards road safety. These aspects should be controlled, not only in the design of a next construction roundabout, but also in the checking of the ones already done.
The wanted purpose is to use the provided advantages by road safety audits to show some advices beyond current regulations.

#90 Aggregate Packing And Coordination Number – A Statistical Approach
Isola R., Nottingham Centre for Pavement Engineering, University of Nottingham
Dawson A.R., Nottingham Centre for Pavement Engineering, University of Nottingham
Synopsis

Most of the past studies of aggregates as used in pavement engineering have focused on large-scale observations of the material's properties, trying to estimate and predict them as a whole using models that, often, descend from purely theoretical considerations. Therefore, the increased ability to describe overall performance sometimes does not explain the underlying causes. As a material's macroscopic behaviour is in some way the outworking of particles interaction, it is unquestionable that a deeper understanding of these interactions and their effects is desirable.
For this reason, the authors' attention has focused on aggregates from a "geometric" point of view, aiming to link the general mechanical properties with small-scale characteristics. In this paper, the possibility of estimating the coordination number (number of contact points that an aggregate particle has with other aggregate particles) within the aggregate (either as an average or as a distribution) is considered of high importance, as other researchers have shown that it has a major influence on aggregate durability and permanent deformation. At this early stage, the study must be conducted in a theoretical way considering an "easy" material whose particles are all spheres. Once a conclusion is achieved with this simplification, the research will go further considering the real particles' shape using parameters such as sphericity, angularity and roundness.
As part of this more general packing theory, the most important step is to predict the coordination number for a random distribution of equal spheres, which is the main subject of this paper. If this target is accomplished, moving this knowledge to the multi-size case will just be one step forward.
It must be said that this study has always been conducted from an engineering point of view rather than from a mathematical one. The authors' ultimate aim is to produce a useful tool, not a theorem.
Coordination number is recognized to be a function of the aggregate's geometry: particle shape, grading and compaction degree are the factors that determine the spatial configuration of this system. If the considered material consists of spherical particles of the same size, two of these three factors disappear and coordination number becomes a function only of the compaction degree. Two different approaches were taken to identify this relationship: random generation of spheres on the surface of a central one and random box filling with equal spheres. Both these methods aim to generate a large data set from which to derive statistical observations on packing variability.
The results obtained from the two methods enable the authors to clearly define the role that packing degree (in the form of solid ratio) has in affecting the sphere assemblies' arrangements. The first method provided a statistical description of the contact points' distribution on particle surface, while the second method delivered equations for predicting coordination number within an assembly of given solid ratio.

#91 Thermal Analysis and Fatigue Verification of the LWR for an Effective Maintenance of the Railway Transport Network

Michele Agostinacchio, University of Basilicata - Italy
Donato Ciampa, University of Basilicata – Italy

Synopsis

The increase in trains velocity and the improvement of comfort on railways belong to both the improvement of vehicles performances and to the use of the long welded rail (LWR).
The analysis of the thermal set-up of the track is fundamental for the sake of the railway transport network performances: it basically deals with the changes in spans and strains occurring daily after temperature ranges. This phenomenon is described by the free dilatation law for tracks without bonds and by the stopped dilatation law for completely constrained tracks.
The thermal analysis of the LWR shows a cyclic soliciting phenomenon belonging to both the daily temperature ranges and to the effects of moving vehicles: from this point of view a repetition of strains which involves an appropriate fatigue verification of the railways can be identified.
For this reason the authors propose a procedure based on the synergic application of the Woehler construction theory for the fatigue curves and of the Miner law of linear accumulation.
Once the Woehler curves are found as function of the different stress state due to the thermal variations and to the moving vehicles passing, the comprehensive damage for both kinds of strains can be quantified by means of the Miner theory.

For this purpose the authors propose the implementation of a calculation software which can automate the thermal lay-out analysis phase, performing the Woehler curve, the internal stresses computation and the damage analysis following Miner's law.
In conclusion, this research is an useful tool for an effective maintenance of the LWR, as it allows the monitoring of the stress state of tracks, especially during the last part of their life cycle, when the temperature range and the moving vehicles passage consequences are more severe.

#92 Mix Optimisation for Cement Mixtures Made of R.A.P. and C&D
Michele Agostinacchio, University of Basilicata - Italy
Maurizio Diomedi, University of Basilicata – Italy
Synopsis
The increasing traffic flows on road infrastructures significantly quicken the degradation time of the pavements efficiency characteristics.
As a consequence, the managing bodies are obliged to consider more frequent maintenance interventions, so as to guarantee high levels of both safety and comfort for users.
Therefore, considering the wide extension of the Italian road infrastructures, one could easily imagine the large amount of milled materials (R.A.P.) coming from maintenance.
Along with R.A.P., there is another waste material which is to be considered also: it is the so-called C&D, which basically belongs from the demolition of civil engineering structures.
Both materials involve serious environmental considerations, the need of new landfills being compulsory.
The re-use of these substances is the solution to this concern, and this reflects the current trend of finding alternative technologies for the use of waste materials.
Actually, waste materials recycling, including R.A.P. and C&D is one of the most interesting technical innovations, both the economical and environmental aspects being considered at the same time.
For this reason, this paper proposes the outcomes of an optimisation study on R.A.P. and R.A.P. + C&D mixes for the manufacture of cement admixtures for road infrastructures, based on mechanical and economical evaluations.

#93 Use of Marginal Materials in Road Constructions: Electric-Arc Furnace Slag
Michele Agostinacchio, University of Basilicata - Italy
Saverio Olita, University of Basilicata - Italy
Synopsis
Electric-arc furnaces are one of the most common ways followed by steelworks for the steel production. In Italy, they generate some two tons of waste materials per year; from an international point of view, only a minor part of these wastes is reused as marginal materials. In road construction the recycling of electric-arc furnace slag is very interesting because of the significant environmental considerations connected with this matter.
The Authors propose the use of EAF slag for the stabilization of soils, giving at the same time a complete survey of the percentages of use and of the deriving benefits.
Therefore, chosen a study soil, three different binary mixes soil-EAF slag are analyzed with slag percentages equal to 10%, 15% and 20%, and finally the 20% percentage is considered the best.
Subsequently, the study considers two additional ternary mixtures, soil-EAF slag-hydrated lime, with optimal percentage of slag equal to 20% and hydrated lime equal to 2% and 4%. The analysis of the five admixtures prepared, from the point of view of constipation tests, CBR tests in optimal conditions and after water imbibitions and compression test with free lateral expansion, allowed an investigation on the performances of each of them and the conclusion on useful design indications for the use of such slag in road constructions.

#94 The Modification of Bituminous Binders by Means of New Generation Polymers
Michele Agostinacchio, University of Basilicata - Italy
Saverio Olita, University of Basilicata - Italy
Synopsis

This paper deals with the qualitative and quantitative assessment of the improvement of rheological properties of bitumen modified with the addition of different kinds of new generation polymers, in order to find a polymer which would give the binder itself highest performances, similar to those already measured for the SBS (styrene-butadiene-styrene).
In particular, the following polymeric materials were used for the purpose: radial SBS polymer with high, medium and low molecular weight; olefin co-polymer alpha and ter-polymers with dienes - EP(D)M - high, medium and low viscosity; thermo-plastic polymers obtained after polymerisation of ethylene by means of different processes as: VLDPE, LDPE, LLDPE, HDPE and two EVA typologies.
Using these polymers, after assuming a traditional bitumen with a 70/100dmm gradation as reference, a 5% in weight modification was carried out by means of a mixer with a mixing head able to prepare a homogeneous and quick solution of polymers into the bitumen.
The rheological analysis was conducted at different temperatures with the HAAKE Rheostress 150 rotational rheometer and with advanced interpretative tools as the Black Diagrams and the Cole-Cole diagrams, the results being an interesting comparison of the performances of the different binders, with significant conclusions on the use of such polymers for traditional bitumen modification.

#95 Porous Concrete Road Pavements: Analysis of Noise Emissions and Applicative Implications from the
Standpoint of both Active Safety and Freeze and Thaw Cycles Resistance

Michele Agostinacchio, University of Basilicata - Italy
Gianluca Cuomo, University of Basilicata - Italy

Synopsis

Starting from previous studies carried out by the same Authors, this research is focused on the definition of the optimal mix design of a road pavement made of new draining porous concrete.
An accurate experimental investigation performed on different real-scale laying allowed the Authors to assess a series of structural and superficial characteristics of the road pavement above mentioned, so as to appreciate all its positive aspects, the perfectible ones being, in any case, highlighted.
In particular, apart from dealing with the mechanical strength of the structural elements against the passage of heavy vehicles and from assessing such parameters as superficial texture, permeability and porosity, the measurements were concentrated on the behavior of the elements themselves in case of very severe winter environmental conditions, with a special interest for freeze and thaw cycles as well as for the use of de-icing salts.
Furthermore, a special care was dedicated to the analysis of noise emissions connected with these new pavements, the measurements being taken by means of appropriate apparatus.
In addition, the research assessed the advantages from the standpoint of users safety belonging to the utilization of this structural elements: not only the spray, splash, aquaplaning and light reflection phenomena are dramatically reduced, but a significant decrease in the braking distance is observed for both dray and wet conditions.
Therefore, thanks to these remarks, the Authors believe that this innovative road pavements, if the perfectible aspects were faced, could be regularly used with positive implications for both users safety and environment protection.

#96 The Influence of Roughness, Evenness and Road Geometry on Wheel-Road Interaction by Means of a Numerical Simulation Procedure

Gianluca Cuomo, University of Basilicata – Potenza - Italy

Synopsis

Starting from the analysis of the vehicle dynamics and from the description of both building and typological characteristics of pavements, this study faced some important features connected with road safety.
Indeed, referring to the former aspect, the research was focused on wheel-pavement interaction under different boundary conditions and, carefully varying certain parameters by means of an appropriate software, it simulated the vehicle behaviour in case of critical situations.

For this purpose a scientific model was arranged, the model itself being capable to simulate the real driving conditions, so as to single out a regressive law for the analysis of grip characteristics as function of both road texture and superficial degradations.
More specifically, the approaching qualitative analysis drove to the characterisation of the variation of several parameters as vehicle speed and acceleration, forces and momenta applied on the wheel, rolling and yaw velocity, etc, and the results were the basis for a further quantitative analysis.
The research developed through some simulations reproducing the real driving conditions on a track designed starting from parameters and characteristics which obeyed the Italian Standards, by assessing the vehicle performance variations and the trajectories changes of a virtual driver, as function of the superficial characteristics of the road pavement.
In short, referring to users safety, with this research the Author developed a scientific model that, after verifying the congruence of its output with the on-site investigations, gives a real and continuous measurement of all the parameters involved in the wheel-road interaction process, so that every situation with any sort of boundary conditions could be studied without troubles.
In addition, the analysis performs some braking simulation on straight roads, in order to find the experimental laws of the phenomenon as function of the boundary conditions (pavement roughness and tyre tread characteristics, unevenness of the contact surface), the outcomes being the starting point for a further investigation for the characterisation of the law regulating the grip phenomenon.
In practice, some of the most authoritative literature references were analysed (Lamm and Herring, Road Star and Stribeck Model), so as to properly interpret the results and validate the model created.
Eventually, the application of some theories coming from the re-elaboration of the above mentioned studies was proposed, the outcomes being very significant for further investigations on wheel-road interaction.

#98 On the SUPERPAVE Asphalt Mixture Gradations for the Mix Design of Traditional and Special Asphalts

Saverio Olita, University of Basilicata - Italy

Synopsis

The Author proposes a methodology for the verification of the fulfilment rate of the particle size distribution specifications of the prescriptions on limit grading curves, which are commonly used for the definition of bituminous asphalt admixtures, with the SUPERPAVE conditions related to the control points and to the restricted zone boundary.
The operative phases of such methodology provide for the determination of the maximum nominal size of the aggregate, referred to the average curve of the limit grading curves in the semi-logarithmic plane of the sieves opening d-% passing and in the dP0,45P-% passing.
Afterwards, once the referring SUPEPAVE chart where to put the prescriptions on limit grading curves is found, the critical points can be characterised in this way: type “α” when the violation of control points occurs , and type “β” when violations of the restricted zone boundary are experienced.
Actions modifying the limit grading curves are proposed for each of these typologies, in order to get to curves consistent with the SUPERPAVE specifications.
The methodology used for the limit grading curves of the main Italian prescriptions shows that, referring to traditional asphalts, small changes can make the limit grading curves consistent with the SUPERPAVE specifications.
On the contrary, the Author found a strong incompatibility with special conglomerates (porous asphalts, stone mastic asphalts, etc).

#99 Photometric characteristics variation of stone pavements under traffic loads

Giuliani Felice, Dipartimento di Ingegneria Civile, dell’Ambiente, del Territorio e Architettura – Università di Parma
Rastelli Silvia, Dipartimento di Ingegneria Civile, dell’Ambiente, del Territorio e Architettura – Università di Parma

Synopsis

The light required for a distinct and easy perception of road environment depends on several factors: the contrast of luminance and colour, the detail size in the perspective frame and the perception distance. The road lighting design plays a crucial role in assuring the driver's ability to correctly recognize the elements in the roadway and the presence of possible obstacles. The most used parameters for evaluating the road surface from a photometric point of view are the coefficient of luminance and the specularity factor, characterizing the pavement brightness and shininess respectively. The Italian regulation summarizes those parameters in two classes. Although the physical properties of the road pavement surface are fundamental because of their influence on the night time driving safety, in tunnels and also in daylight conditions, how much attention does the road designer pay to them? How much does the typological choice of materials for pavement surface affect the right calculation of road lighting system?
This paper, which is the synthesis of a complex theoretical and experimental investigation, aims to give a contribution to the study of the interaction between pavement and light, through the analysis of the evolution of photometric characteristics of stone road coatings, from the manufacturing to the service conditions. Advanced equipments allowed to determine the field variability of colour, the luminance factor in diffuse light conditions (daylight and street lighting) and the retro reflection coefficient in conditions of vehicle lamp illumination. These quantities have been evaluated as functions of polishing level and wet condition.

#100 Experimental evaluation of critical conditions for surface dressings

Montepara Antonio, Dipartimento di Ingegneria Civile, dell'Ambiente, del Territorio e Architettura – Università di Parma
Giuliani Felice, Dipartimento di Ingegneria Civile, dell'Ambiente, del Territorio e Architettura – Università di Parma

Synopsis

The Authors present an original equipment, the Surface Dressing Simulator, designed and realized to reproduce, on small areas, the sequential spread of bituminous emulsion and chipping aggregates, typically required for surface dressing applications.
The prototype has all the characteristics of combined means used for cold treatments (tank, spraybar, chipping spreader) and it is able to simulate critical conditions in terms of longitudinal and transversal slope of the laying surface and, at the same time, to control the longitudinal speed and the materials amount.
The apparatus allowed to calibrate an hydraulic model of theoretical flow for bituminous emulsions on road surfaces with high slope, typical of local roads network, where often the surface dressings fail because an excessive flowing of binder takes place or the laying is not uniform.
The theoretical analysis and the experimental validation suggested practical recommendations in terms of longitudinal speed of tank and optimal setup of spraying nozzles (number, chink extent and height) in critical contexts, not unusual in practice.

#101 Density Gradients in Asphalt Pavements

Prof Scott Shuler, Colorado State University

Synopsis

Asphalt pavement density measurements were made using a conventional nuclear density guage and a relatively new device utilizing a dialectric physics. Five sets of density tests were made at each of nine sites during, or immediately following, paving operations between July and September, 2004. Testing at each site attempted to capture differences in density caused by segregation under five distinct sets of circumstances. These included strip segregation along the centerline created by the auger gearbox of the paver, other visible segregation caused by practices such as truck emptying practices and paver hopper wing folding, transverse segregation caused by inherent design configurations of the paver including the slat conveyor system and screed extensions and stopping of the paver. Control sections were included where segregation was not visible during construction. Tests were conducted at random for each data set and replicated so that rigorous statistical analysis could be conducted. Results indicate that for the 'strip' and 'visible' data sets, an average decrease in density apparently occurs in the location of the segregation when all nine sites are included in the analysis. However, variability of the density data for all nine sites was very high. This variability is likely related to the

differences in segregation occurring at each site. Also, a significant density gradient was measured in the transverse direction to paving and in the longitudinal direction when the paver stopped. Density gradients measured in the areas of segregation seem logical, but those measured in locations where segregation was not visible during construction indicate that either segregation is occurring beneath the surface of the pavement where it is not visible or that a lack of uniform density is occuring during paving operations.
This study evaluated the ability of the nuclear density meter and a dielectric measuring gauge to measure differences in density for areas of asphalt pavements with and without segregation. Nine projects were evaluated during the construction season of 2004 in Colorado, USA. Five different sets of data where segregation is known to occur or potentially occurs and two control sections were evaluated for each project. A minimum of five and up to eleven locations within each data set were measured.
The results of this work indicate the nuclear density gauge should be helpful for identifying potential segregation in asphalt pavements and that significant density differences exist in the insitu pavement after construction in areas where segregation is not apparent.

#104 Multimodal Transport Axis Design. Analysis Of Critical Matters Depending On Railway-Motorway Closeness

Andrea Capra, DIIAR - Politecnico di Milano
Tullio Giuffrè, DIIAR - Politecnico di Milano
Savino Rinelli, DIIAR - Politecnico di Milano

Synopsis

Planning an integrated network of European transport infrastructures (multimodal transport axis or corridor), where both transport lines and junction coexist, problems related to the connection of pre-existent infrastructural and natural networks aren't often duly evaluated. This consideration moves from Authors' design experiences on many segments of AV/AC railways in the North of Italy. These experiences showed involvements and consequences of preliminary layout and alignment choices on complementary works, the role of which is very important to solve the interference between the pre-existent networks and the new infrastructures system, for example the road and hydraulic ones.
Design problems, building costs and relevance of complementary works are often comparable or even more than the ones concerning the new axis infrastructures.
In this way, the corridor layout is a determining factor. Infrastructures layout distance (i.e. railway and road), project level design and altimetric offset are the main parameters which constrain design of cross constructions, environmental mitigation works and safety systems, with implications on environmental impact and costs. That is why consequences of the axis infrastructural choices can be sometimes worse than the expected ones.
Trying to orientate design choices, and also to make Public Administrations aware of the consequences depending on general setting-out criteria, the present article takes in exam a case study in advanced planning stage. It analyzes the main critical matters due to corridor construction and highlights for each of these both the most influencing parameters on design scenario and the different options design effects.

#105 Use Of Ultra-Thin Whitetopping In The Rehabilitation Of Degraded Flexible Pavements

Pasetto M , Construction and Transport Dept., University of Padova, Via Marzolo 9, Padova (Italy)
Bortolini G, Construction and Transport Dept., University of Padova, Via Marzolo 9, Padova (Italy)

Synopsis

The choice of the most appropriate functional and structural rehabilitation technique for damaged road pavements obviously mainly depends on the type of surface degradation. The most common rehabilitation technique for flexible pavements deals with the resurfacing of the degraded wearing course by means of a bituminous layer, when it can't be completely replaced by similar mixtures.
Nevertheless, maintenance of degraded flexible pavements can be carried out resorting to a different procedure, which is rarely used in Italy, although it is quite popular abroad: Ultra-Thin Whitetopping (UTW). It involves the damaged pavement being resurfaced with small thin cement concrete slabs.
The interaction between the existing bituminous pavement and concrete layer generates a monolithic system, the performance of which is conditioned by various parameters: the volume of vehicular traffic, environmental

conditions, the thickness of cement and bituminous concrete layers, the distance between joints, the adhesion between layers and maintenance technique.
The paper describes the results of an Italian application of this technique. The experiments regarded the identification and characterization of the existing bituminous pavements (through cores and bearing capacity tests), the design of the UTW, the cement concrete mix design (PP and SB fibres were added to the mixture to enhance compressive strength and elasticity), the mechanical characterization of the new layer (by means of compressive strength and dynamic modulus), the construction of joints, the execution of loading tests on the slabs and measurement of longitudinal, transversal and vertical deflections by strain gauges and LVDTs.
The study emphasizes the effectiveness of the maintenance technique. The UTW ensures a good bearing capacity to the pavement, thanks to high values of compressive strength and elastic modulus of the concrete, according to future traffic needs. Moreover, deflections are rather limited. Adequate functional properties (evenness, skid resistance) are also guaranteed.

#106 The "Net" System Metrocargo®: An Intermodal Solution For The Economic Integration Of The Territory Through The European Corridors Of Transport

Nordio, A., DIMSET- Transportation Section, Faculty of Engineering, University of Genoa
Porta, G., DIMSET- Transportation Section, Faculty of Engineering, University of Genoa
Servetto, M., DIMSET- Transportation Section, Faculty of Engineering, University of Genoa

Synopsis

Any new development in logistics and transports must fit with the existing infrastructures, with a broad "international" outlook, meaning "across" nations and European regions.
In other words, the existing European infrastructures should be used and properly integrated with those being planned, with the purpose of integrating and balancing the available transportation modes. The European transport corridors on which the whole multimodal and multifreight logistic process is based must not be seen how a "wound" for the territory, but as an important opportunity to reach the said aim.
Therefore, an efficient system should optimize the overall design and use the best suited technologies to reach the best possible interaction between transport infrastructures and territory.
Our research shows that the "Metrocargo®" model can be an effective way to utilize the existing transport infrastructure and to assure a diffused economic accessibility on the territory.
"Metrocargo®" has been conceived by Eng. Guido Porta and it has been the object of several studies, many of which in cooperation with the Transportation Section of the DIMSET in Genoa. All studies concur to the systemic viability of "Metrocargo®".
"Metrocargo®" is an innovative system of freight transfer that also represents a new way of conceiving and organizing the intermodal transport of goods. It consists of a network of scheduled cargo trains and a number of terminals, in which cargo units are horizontally transferred from one train to another and/or to trucks for the last leg or to cargo ships. This process determines a remarkable reduction of transport costs and delivery times.
"Metrocargo®" can transfer significant volumes of traffic from the road to the railroad and is compatible with new logistic concepts, such as the "Highways of the Sea" involving cargo ferries.
The application of "Metrocargo®" - a "net" system by definition - on the new European corridors could result in a double function: to act as a catalyst for a more environment-friendly freight transport development, and to increase the economic competitiveness of small enterprises in remote territories.
In conclusion, we mean to evaluate how a diffused transport system like "Metrocargo®" can become a catalyst for an integrated market of full European dimension, giving remarkable benefits to the territories through which the planned transport corridors run.

#107 Computer Simulation of Hydroplaning Effects on Geometric Design - Optimization Strategies for Road Sections with Critical Rainwater Drainage

Wolfram Ressel, Universität Stuttgart, Germany Institute for Road and Transportation Science
Steffen Herrmann Universität Stuttgart, Germany Institute for Road and Transportation Science

Synopsis

Heavy rainfall is a prime factor which reduces driving safety intensely. Tire grip decreases and in cases of higher water film thickness, complete aquaplaning of vehicles is likely to occur. Primarily, wide multi-lane roadways are concerned, as flow path lengths of the runoff water are high. Furthermore, typical roadway alignment types can about triple the drainage path lengths compared to “normal roadway arrangement”. These critical types are cross slope change-over and sag vertical curves, or a combination of them.
To predict the hydroplaning-performance of road sections subject to its geometric design and surface roughness, a computer model was developed. The model is based upon on a discrete surface-model. Upon this surface, one-dimensional rainwater runoff paths are generated. For each flow path the water film thickness is calculated by a one-dimensional finite volume scheme. The intermediate range between the flow paths is filled by an interpolation algorithm. As result, the water thickness for each mesh is given. On this calculated water film thickness topography, fictitious vehicle lanes were applied. The water film traces or hydroplaning speed traces under these lanes are the basis for the valuation of the hydroplaning-performance.
The model is intended for use in the geometric design process of new pavements as well as in the elimination of traffic accident hot spots caused by insufficient surface water drainage. With its help, an optimization of pavement surface drainage – under safety and economic aspects – is feasible. For the elimination of existing safety weak spots an automated ex post correction can be accomplished. For this purpose, drains (in between lanes or across travel lanes or transverse), grooves (both along and across) and special pavements like porous asphalt can be applied on any road geometry (particularly transition curves respectively sag vertical curves or a combination between them). In adaptive scenarios each element and alignment option is automatically evaluated by the program as long as an optimized constellation is found. As a result of a number of model passes, a list of recommendations for the optimized use of drainage elements and geometric design elements was given.

#108 A Proposal for a Normative to Regulate Noise Generated by the Operation of Motor Vehicles on Mexican Highways

TorrasOrtiz, Sandra, TéllezGutiérrez Rodolfo, RascónChávez Octavio, Flores Puente Miguel, Mexican Institute of Transportation (IMT)

Synopsis

In Mexico, as in every country, noise generated by highway traffic has increased over the last number of years. This represents a serious health and environmental issue which up to now, has been poorly researched and poorly attended.
This paper presents a proposal for a federal normative, which would regulate and reduce noise generated by the operation of motor vehicles on Mexican highways. The proposal is based on research and analysis carried out by the Environmental Department of the Mexican Institute of Transportation (IMT), which included field measurement of noise generated by highway traffic in four Mexican States. These studies have been published by the IMT, and include all noise measurement data obtained at highways selected by means of their high traffic volume.
Taking both the analysis of obtained results and current international maximal noise values into account, this report proposes a standardised measuring method and a domestic maximal noise value for highways, incorporating a reduction of one dB (A) each year, which would align in the short term domestic maximal values with international regulations.
By undertaking these studies, the IMT seeks to improve knowledge and consciousness of the negative environmental impacts of highway construction, operation and maintenance. Furthermore, the exchange of information between countries with a similar problematic can contribute to finding improved methods to mitigate noise pollution on the highways.

#109 Heavy Rail Transit Station Physical Condition Index: An initial framework

John T. Crocker , Georgia Institute of Technology

Synopsis

This paper presents a proposed Condition Index for Heavy Rail Transit stations. Based upon existing indices used in bridge and pavement management, the index is designed to help transit agencies in management of

their physical assets. The proposed index examines with physical components of the transit station and utilizes a 10-point scoring method. Results of a field test on an operational system are discussed along with opportunities for further research and improvement of the index

#110 Categorization versus hierarchy of networks: recent developments in road network planning and design in Flanders

Dirk Lauwers, University of Ghent, Department for Mobility and Physical Planning

Synopsis

The aim of this paper is to present a reflection on recent trends in road network planning and design in the Flanders Region in Belgium. This reflection is based upon compilation and confrontation of recent planning documents with each other and with traffic design theories.

The Flanders Region contains the densest road network in Europe. But it also contains major congestion areas and is very badly ranked in road accident figures in the EU15.

A milestone in a way towards a structural approach of these problems has been the drawing up and the approval in 1997 by the Flemish Government of the Spatial Structural Plan for Flanders. In this plan a hierarchy on three scale levels (international + Flanders / provincial / local) but also a functional categorization of the road networks is introduced. The categorization is based on three functions of roads: connecting, collecting and giving access. As the implementation process of this plan progresses (re-)design standards on the layout of the network as well as of the infrastructure are being developed. It seems that apart from the hierarchy this functional classification is a very decisive criterion in the choice of these standards: e.g. number and typology of crossings, design speed. However a key question regarding traffic safety oriented design consists in the prevailing of distinguishing road typology based on the connecting or collecting or giving access function, above administrative hierarchy. It has also become clear that a unimodal car oriented approach can't solve the above mentioned problems: so the provinces have introduced a new category of roads facilitating public transport in their spatial and infrastructure plans, provinces and local authorities have focused also on biking networks (instead of biking routes). Figures are showing that in 2003 for the first time after more then 25 years the continued increase of car traffic on the Flemish roads was stopped and that on the contrary the public transport use and biking significantly increased. Furthermore two approaches can be distinguished in the restructuring of the urban and regional road networks: a hierarchical concept resulting in tree-like structures on the one hand and concepts based on spatial typologies of roads (boulevards, parkways, ...) organized in grid-like patterns on the other hand. Categorization of roads should not lead to uniform road design but to a stepwise approach of the design process starting with the definition of a requirements programmed that partially is conditioned by the functional category of the road, leading to a detailed design using a limited number of traffic engineering and spatial concepts for roads and streets.

#113 Brera - Garibaldi Environmental Island in Milan

Cassani Federico, Fabio Casiroli, (Systematica s.r.l.)

Synopsis

This project, carried out during the year 2001 and at the moment on the way of implementation, represents one of the first Environmental Island projects and the biggest traffic calming scheme implemented in Italy today.

The main objective of this paper is to demonstrate how, thorught an in depth analisys of the existing conditions, a detailed transport modelling phase (both on the "macro" and the "micro" levels) and traffic management and planning procedures, it is possible to develop a successful and environmental friendly urban design project.

#115 An evolved concept of connectivity: the "Service reliability"

Prof. Ing. Pasquale Colonna, PolytechnicTH University of Bari (Italy), Department of Highways and Transportation
Ing. Nicola Berloco, PolytechnicTH University of Bari (Italy), Department of Highways and Transportation

Synopsis

During the last years, the research on transport network reliability has been focused on the multiple features of the wide concept of reliability (connectivity, terminal, capacity, travel time and cost reliability). Several indicators were introduced and many techniques were applied in order to calculate them. In this way some micro-levels of study were systemized, but at the same time the problem lost connection from a general point of view.
The study of single aspects of reliability, resulting from the specific analysis to carry out and from the aims to reach, has to be preceded by a preliminary and general study to characterize the problem at a less specific level, which can support the following strategies of study.
Connectivity surely represents the less complex step in reliability studies and at the same time it is one of the most powerful indicators currently used in research. However, its binary approach (link working or not working) on one hand represents its effectiveness and efficiency, and on the other it precludes the implementation to daily cases in which the connections work in one intermediate situation between the two limit states (temporary increases of traffic, maintenance works, incidents, etc).
A better representation of daily situations could be obtained by measuring connectivity with a variable which can assume any value in the range one-zero.
For this purpose it seems useful the already existing theory of traffic levels of service, used for planning and checking street sections, that effectively includes most of the variables affecting traffic conditions, such as geometry and flows. The indices associated to different links, related to the expected or measured levels of service, can be set in the planning stage or calculated for already existing situations, giving the methodology remarkable versatility and numerous cues of deepening.
In this study, a new method of calculation of reliability is presented. In the extreme cases it falls back in the connectivity and, in the other ones, gives a new indicator representing time and travel cost, comfort and satisfaction of the customer, supplying the searched general vision to reliability.

#118 Study Of The Acoustic Performances Of Pavements Made Of Bituminous Mixtures

Massimo Pisciotta, Department of Highways and Transportation - Politecnico di Bari
Ubaldo Ayr, Department of Applied Physics - Politecnico di Bari

Synopsis

In the following paper the Authors present the results of a study based on the comparative evaluation of the sound absorption characteristics of bituminous mixtures with different compositions. The results have been obtained by determining experimentally the values of sound absorption coefficients α of the mixtures.
Draining mixtures, draining mixtures with fibres in pure cellulose, double draining layer mixtures and antiskid mixtures have been manufactured to be subjected to the Kundt's tube standard method.
This study shows the contribution that a binder course placed under the friction layer can give to sound absorption.
All the samples have been subjected with various frequencies from 400 to 1800 Hz.
The results of this study prove the substantial equivalence of sound absorption characteristics between draining mixtures and draining mixtures with fibres; also double draining layer mixtures and antiskid mixtures have provided good performances.
Moreover, the contribution of the layers used under the friction layer appears very important in relation to sound absorption.
The methodology used has revealed itself suitable for comparative measurements of sound absorption in mixtures of different materials and compositions used to make friction layers.
The measurement protocol applied to the experimentation, based on a statistical survey, allows finding possible errors made during the measurement or manufacture of the samples by who operates.

#119 Barriers To The Use Of Efficiency Assessment Tools For Road Safety Policy

Pierluigi Aloia, Francesco Filippi, Luca Persia, University of Rome "La Sapienza" – Department of "Idraulica, Trasporti e Strade"

Synopsis

It is well known that economic resources dedicated to the implementation of road safety measure are very often limited. In this view, the availability of efficiency assessment tools (EAT) that help decision makers to identify and

to rank the most suitable safety measures, in terms of less money invested and more lives saved, is fundamental to optimize the use of the available resources.
Traditionally, EAT, such as cost-benefit and cost effectiveness analysis, are commonly applied for physical road safety measures within larger infrastructure investments, while their use for "minor" investment as road safety measures is less common.
In this paper are described the results of a specific study aimed at assessing the real use of EAT in road safety measures planning and implementation in European countries, and, mainly, at identifying the barriers that limit their application are described. The study has been performed within the EU funded project ROSEBUD, a thematic network, started in year 2002 and currently going on. The project is being conducted by several European road safety research institutes (e.g. DITS, BAST, SWOV, TOI, TRL), also involving political representatives and decision makers.
The use and the barriers reducing the use of EAT have been assessed through specific surveys to road safety decision makers at different level (e.g. urban, regional, national). In order to have reliable information and not influenced answers , the questionnaire has been developed with "open answers". Moreover, to increase the reliability of the results, all the interviews have been conducted personally, so that the interviewer could guide the interviewees throughout the questionnaire.
The sample is represented by a total number of 83 interviews; 6 of them carried out at European level, 50 at national and 27 at local/regional level. The total number of countries involved is 7; in addition representatives of the European Commission have been interviewed.
The analyses of the most interesting results are reported in the paper. The comparisons have been performed among Italy, European average values and the Northern European Countries; these are Norway, Netherlands and Germany that have been gathered together being the most experienced countries in road safety issues.
Results obtained stressed that in Italy CBA and CEA are still not part of decision makers' cultural and technical background, and not having a clear definition on responsibilities seems to have hindered its spread among the experts. Moreover, another big constraint to their application is related to the lack of knowledge and data about the impacts of road safety measures. At present, the analysis performed are characterized by a detailed costs analysis while impacts are only estimated in a qualitative way.

#120 P&R Behavior Analysis and Models in Metropolis: A Case Study in Beijing, China
By Hongzhi Guan, Beijing Key Lab of Traffic Engineering, Beijing University of Technology, China
Huanmei Qin, Beijing Key Lab of Traffic Engineering, Beijing University of Technology, China
Xiaoming Liu, Beijing Key Lab of Traffic Engineering, Beijing University of Technology, China
Synopsis
Building the P&R system is an effective method to lessen the traffic pressure in the Metropolitan center and to increase the trip efficiency.The research from the aspect of travel behavior will provide the foundation for planning and effective utilizing of the P&R system. In this paper, a parking behavior survey in Beijing is introduced. On the basis of analysizing the results of the survey, the influential factors for the P&R behavior are discussed with a binary logit model. The results show that the trip time and cost are very important influential factors for the P&R behavior. In addition, the departure place, the terminal parking place, trip purpose, occupation and income level of the travelers also have some influence on the P&R behavior.
Key words: P&R; Revealed preference survey; Stated preference survey; Logit model

#123 Optimization Analysis to Detect Significant Variables in Road Safety
Gaetano Bosurgi, Dipartimento di Ingegneria Civile di Messina
Antonino D'Andrea, Dipartimento di Ingegneria Civile di Messina
Orazio Pellegrino, Dipartimento di Ingegneria Civile di Messina
Synopsis
The control of the safety conditions in the phase of design or check of a road, represents a complex problem according to numerous factors and variables indispensable to formulate an objective assessment.
In the last years, this argument has been studied very in-depth, producing new criteria and methodologies to approach the problem.

In particular, the necessity of a systemic study is emerged, where road and driver become the most important factors to improve the usual safety analysis, especially with environmental context rather articulated.
The Italian Road Standard, the DM 5.11.2001, foresees the instrument of derogation in case of difficult conditions (local, environmental, landscape, archaeological, economic). Nevertheless, there is always the obligation to prepare suitable safety checks to support the design choices and to avoid the overcoming of certain threshold values.
On this subject, a survey promoted by the Società Italiana Infrastrutture Viarie (SIIV), has highlighted that some engineers, addressed to the control of road designs, have expressed many doubts about the limits of validity of the road standard.
To exceed these problems, the paper analyses the most influent parameters inside the mathematical formulas through reliability analysis techniques. In this way has been possible to find the validity interval of the variables, having as function objective the maximization of the safety.
The application to some practical cases has demonstrated that this methodology can be easily used to design or to verify a road, reducing the subjective judgement and evaluating only the variables more influential.

#124 The Use of Image Analysis in Determining Some Traffic Flow Characteristics

Gaetano Bosurgi, Dipartimento di Costruzioni e Tecnologie Avanzate – Università di Messina
Antonino D'Andre, Dipartimento di Costruzioni e Tecnologie Avanzate – Università di Messina
Orazio Pellegrino, Dipartimento di Costruzioni e Tecnologie Avanzate – Università di Messina

Synopsis

The use of over-simplistic models (occasionally borrowed from the field of railway traffic research and suited, therefore, to a constrained mode of driving and rationally organized traffic) to represent driving behaviours has often proved misleading in the most critical of driving conditions.
The most restrictive scenarios have always been thought to be those relative to an isolated vehicle and to a concept of speed linked only to road geometry.
A picture of effective driving conditions has very often been built up by monitoring vehicle speeds at preordained points along the road using instruments such as speed cameras or coils but data relative to variations in speed and trajectory as a function of traffic and environmental complexity have been lost in the process.
Given that the main justification put forward for not using more complex diagnostic tools is their cost, this paper aims to illustrate a procedure designed to derive some of the most representative variables, such as speed, acceleration, distance between vehicles and trajectory using Image Analysis techniques.
In particular, video images recorded using simple cameras positioned inside the vehicle or at fixed points on the road have allowed very reliable data to be collected at very low cost.
The methodology also solves the problems associated with positioning the speed camera at a fixed point, which notoriously gives speed readings that fail to reflect situations of real ranger; it also provides easy-to-read data on interactions between vehicles.
In this paper the aim is not to propose new models of driving behaviour, already illustrated in the lately by the Authors (see the References), but suggest a technique useful to monitor the driving behaviour of unaware users belonging to the traffic flow. This method will allow in the next future to integrate and improve the existing models about with less effort and cost.
The application was tested on a provincial highway in the municipality of Messina known for its high accident rate and provided valuable information, the reliability of which can be established probabilistically.

#125 GPR Investigation of Cobblestone Road Pavement Degradation

S. Colagrande, Dipartimento di Architettura e Urbanistica, Università di l'Aquila, Italia
D. Ranalli; M. Scozzafava; M. Tallini, Dipartimento di Ingegneria delle Strutture, delle Acque e del Terreno, Università di L'Aquila, Italia

Synopsis

Structural degradation of road pavements is a threat to traffic safety. Defects or damages in the road surface make driving unsmooth and uncomfortable and increase the likelihood of accidents.

Ground Penetrating Radar (GPR) has been successfully used in non-destructive investigation of road pavement degradation and identification of its causes.
The paper describes the results of a GPR study that was conducted on the cobblestone road pavements of the historical center of L'Aquila (Abruzzo, Italy). The investigation had the purpose of finding correlations between the following variables: type of stone surface; traffic load; road surface degradation; and results from GPR scans. Both qualitative analyses (anomalies on radar sections) and quantitative analyses (curves of radar signal attenuation with depth) were carried out. The investigation was conducted on 15 sites representing various combinations of the above-mentioned variables. Each site had a surface area of 3 x 3 m. The antenna arrays had a nominal frequency of 1,600 MHz (down to a depth of 1 m) and of 600 MHz (down to a depth of 4 m). The scans were performed on grids with a mesh of 1.5 and 0.5 m, respectively.
The investigated sites were grouped into classes of pavement surface degradation (PSD) and of traffic load (TL). The groups (no degradation, average and high) of the first index were established on the basis of direct observations of defects. Conversely, the groups of the second index were based on the number of passing vehicles per unit of time. Also in this case, three classes were defined: heavy, average and low. The cobblestones used in the investigated sites were made up of red porphyry from the Bolzano area, local limestone and leucititic lava from the Lazio Region.
Comparisons between radar attenuation curves (and related PSD and TL classes) and types of cobblestone elucidated some aspects concerning GPR calibration in the investigation of the cobblestone road pavements.
In terms of types of road pavement and PSD and TL classes, the porphyry pavement had a more marked electromagnetic wave reflection than the limestone or leucititic lava ones. This is due to the fact that porphyry has a high iron content, which amplifies incident radar signal reflection.
In terms of traffic on sites belonging to the same PSD class and with the same pavement, heavy-load roads had a more pronounced electromagnetic wave reflection than average- or low-load roads. This finding is justified by the more significant destructuring of the cobblestone road pavement and, ultimately, by increased porosity of the road embankment, whose internal voids induce the multiple reflections observed in the attenuation curves.
Sites with the same type of road pavement and the same TL class were also investigated under variable surface degradation conditions. The more degraded is the surface degradation of these sites, the more rapidly dampened are their attenuation curves with depth. This observation is due to the fact that a higher surface degradation (high PSD class) immediately dampens the reflected radar signal before it reaches the deeper layers of the road structure.

#126 Roundabout's Performance Evaluation
Camus R., Dall'Acqua M., Longo G., Department of Civil Engineering – University of Trieste
Synopsis
The paper deals with traffic management and in particular with the estimation of roundabout's performances.
Many approaches have faced the problem of entry capacity and delays estimation; anyway, there is not a common and universally accepted procedure to the evaluation of roundabouts. Many models refer to an empirical approach; many others refer to a more theoretical one. Furthermore, all these approaches consider the roundabout facility as a succession of independent intersections, whilst, mainly in congested facilities, it should be considered as a multi-junction node.
In this paper, a new approach is presented, refined and applied: the input legs and the circulatory area of a roundabout facility are modeled as elements of a multi-junction node.
The new approach allows the estimation of capacity and delays for each entry leg and for the node as a whole. It is based on a model developed for on-ramp junctions segments on freeways; the same model has been applied to each approach leg of a roundabout, and specific requirements due to the presence of a circulatory roadway have been met. In this context the main problem is the relationship between the circulating and the entry flows in each input leg: this problem could be solved through an iterative process in order to find a final equilibrium solution.
If the circular relationship between entering and circulating vehicles has been solved, it is possible to well estimate entry capacity and queues development for each approach leg within a given time interval step; in such a way, it is possible to overcome the hypothesis of the roundabout as a succession of independent T-intersections.

Queues evolutions could be studied in a more detailed way than in a macroscopic approach. At the same time, the proposed method could be classified as a mesoscopic one, because it doesn't need the amount of parameters and hypotheses which are needed for a microscopic method.
First results of the proposed model have been deeply compared to the results of existing macroscopic and microscopic models; the proposed procedure is in accordance with existing models throughout a correct calibration of the parameters introduced.

#128 To drive the Appropriate Speed in Curves
Dirk Ebersbach, Institute of Road Infrastructure Mommsenstraße 13, 01069 Dresden, Deutschland
Synopsis
Introduction / Statement of the Problem. Fundamental Principles of the SC-System. UInitial Parameters for the Vehicle Speed. General. Vehicle Speed Initial Parameters for Single Curves. Vehicle Speed Initial Parameters for Sections approximating to Similar Bendiness of Road. The Choice for S.A.N.T.O.S. Application and Test Drives. The Current Situation and Future Trends. Bibliography

#129 A model for the analysis of local dynamic effects for high speed railway lines
Gaetano Bosurgi, Department of Civil Engineering - University of Messina
Andrea Trio, Department of Civil Engineering - University of Messina
Synopsis
For a long time, there is the necessity to search new solutions to design and to realize the railway superstructure, in relation to the stability of geometry, to the maintenance necessity and to the reduction of the vibrations shot out from the train during the running. As known, the experimentation in this field has been offering for a long time good results, thanks to some European and especially to some Japanese networks.
In this way, it has been established the choice to realize the railway line in absence of ballast bed, considering more and more satisfying attenuation systems with the aim to improve the security, working and pollution conditions in terms of transmitted vibrations. Nowadays, the standard solution foresees the realization of superstructures composed of prestressed reinforced concrete slabs, installed on a base and interposed by a cement asphalt mortar layer of anti-vibrational laggings or moreover, of mechanical systems that are able to reduce the effects caused outside.
In this paper is analysed the dynamic response of a typical superstructure for high-speed lines. A particular attention goes to the study of a model to quantify the vibrational effects, caused on a bedding support of a roadbed, during the train in transit. The knowledge of caused local effects represents, in facts, a fundamental indicator for the optimization of the project solution.

#130 Adapting Safety Perfomance Functions for signalized four-legged intersections
Losa M., Professor - Department of Civil Engineering University of Pisa
Terrosi Axerio A., Ph.D.Student - Department of Civil Engineering University of Pisa
Synopsis
Safety Performance Functions have several important uses in road safety analysis. These functions, also known as Accident Prediction Models, are equations able to give an estimate of the expected average number of accidents at similar entities, relating the annual accident experience of an entity to its features.
These safety tools can forecast the expected annual number of accidents for a given "past period" or "future period", in way to allow the assessment of safety performance of an entity and the safety effect of design changes for new road projects and treatments to existing road. Moreover the application of these models can avoid the problems closely related with the police-reported accidents which are influenced by reportable criteria, police procedures, lack of reporting and errors to report.
These models have to be properly calibrated, but this task is particularly hard due to the complexity to specify the mathematical form, the accommodation of the peculiarities of accident data and the transferability of models to other jurisdictions.

The aim of this study is to develop a Safety Performance Function for four-legged signalized intersections; some of these are located on two collector roads, crossing build-up areas, while the others are in urban areas, so that all selected intersections are characterized by urban environment, factor that can directly influence the count of the expected accidents.
The methodological approach used during this research lies on choosing an appropriate base model and on verifying its suitability to the real traits of the examined context.
In order to obtain this purpose, it has been chosen one of the model for four-legged signalized intersections proposed during a research conducted in Toronto. It calculates the expected accidents for these types of entities as the product of the intersection traffic demands raised to a power; exactly the Toronto Safety Performance Function relates accidents to the entering AADT of the major and minor roads, whose exponents change with intersection features and type of accident data (injury or all accident severities).
The selection of the more suitable model form has been based on the integral-derivative (ID) method. Basically the method consists of creating an empirical integral function (EIF), for each independent variable, and then to compare the EIF graph created with pre-established graphs of well-known functions (power, gamma, polynomial, etc…) in order to indicate the proper relationship between the dependent and independent variables.
In order to obtain the coefficients of the selected statistical model it has been implemented a calibration procedure that, by using the method of the maximum likelihood function, assesses the model parameters that make this function the largest.
The validity of the selected models and of its coefficients has been investigated with the Cumulative Residual (CURE) method: this method consists of plotting the cumulative residuals (the difference between the actual and fitted values for each intersection) for each independent variable. It is possible to assert that the selected Accident Prediction Model fits with good accuracy the data available as the cumulative residuals oscillate around the zero value and moreover lie between their two standard deviation boundaries (62σ*).

#134 FEHRL Vision 2025 For Road Transport In Europe

Bellucci P., FEHRL member - ANAS S.p.A.– Centro Sperimentale Stradale di Cesano, Roma
Fusco G., Università degli Studi di Roma “La Sapienza”, Dip. Idraulica, Trasporti e Strade, Roma
La Monica S., FEHRL member - ANAS S.p.A.-– Direzione Centrale Lavori, Roma

Synopsis

The Forum of European National Highway Research Laboratories (FEHRL) was formed in 1989 by the National Highway Research Laboratories in EU and EFTA countries. The mission of FEHRL is to promote and facilitate collaboration between its institutes and provide high quality information and advice to governments, the European Commission, the road industry and road users on technologies and policies related to roads. To promote common research activities a five-year Strategic European Road Research Programme (SERRP) is usually defined through detailed implementation plans. In implementing its fourth version of SERRP, FEHRL has taken a long-term “ Vision” of the future of roads and of the research needed to support their development and operation. The aim of the Vision 2025 is to illustrate the current position and key trends of road transport, propose a range of possibilities for the future, draw out differences, identify decision areas and ultimately consider consequences for 2025.
The “Vision 2025” begins with a brief overview of the current position of road transport across Europe and of the known time trends at present. Based on that knowledge, likely future changes were drown out and a number of possible scenarios constructed, starting from two extremes: an ideal future supply-side and a do-nothing or do-minimum supply side. Three other scenarios between these extremes were examined: a government-driven scenario, a market driven scenario and a sustainability scenario. From them a single future based on the likely technological, societal and policy options was drawn up. Future technological and financial possibilities were considered with respect to seven primary “desirables”: that travel should be smart, safe, clean, comfortable and reliable; that access to business and leisure activities should be available in proportion to value and need, and that each part of the network should be suitable for its function.
Accordingly to the previously mentioned analysis, four categories of enquiry and development were identified to fulfil future needs: design and production systems; environment, energy and resources; safety and security; mobility, transport and infrastructure. For each category a series of desirable research matters were suggested.

The results arisen from this "Vision" were carried out capturing those elements of the projection with a reasonable level of probability, leading to conclusions that are common to a range of scenarios. How these scenarios will develop and which of the issues emerged in this study will prevail depends on the policies that are pursued in the coming years.
One of the most relevant issues of the Vision is the linkage between road, vehicle and driver, enabled by the continuous progress in communications and IT systems, which constitutes the core of the Intelligent Transportation Systems (ITS).
Initiatives in ITS field begun in the 1960s led to many implementations that introduced automation and real time information in the traffic management and culminated in the automated highways initiative, which represents the most fascinating and debated vision of future road transport.
Several field experiments demonstrated automated highways are technically feasible. However, there are many barriers to their actual development that include costs, liability, psychological and institutional issues.
A more practicable alternative, which many studies predict being largely implemented by 2025, is a partial application of automation that leaves the driving task to the driver and assists him or her by continuously verifying safety conditions.
In the paper a survey of experiments carried out in USA, Europe and Japan will be presented and the main technical issues to integrate road condition detection sensors, traffic monitoring devices and vehicle control sensors will be discussed.

#140 The Savone Bridge on the SS 7 "Appia": Real Time and Topographic Monitoring of Thermal strain
Giancarlo Atza, II Università degli Studi di Napoli, Facoltà di Architettura "Luigi Vanvitelli", Dipartimento di Cultura del Progetto
Vittorio de Riso di Carpinone, Università degli Studi di Napoli "Federico II", Facoltà di Ingegneria, Dipartimento di Ingegneria dei Trasporti "Luigi Tocchetti"
Salvatore Frasca, ANAS Napoli 2nd road maintenance center Caserta, Compartimento Viabilità della Campania
Maurizio Mirabile, BMR International, Contrada (AV)
Synopsis
The Savone bridge is located along the SS 7 rural road "Appia" in the southern territory of Francolise town (Caserta county). It overpasses the Savone river and it is about 150 m long. It has been built in the first part of the 50s and now it shows some problems that have been decided to investigate.
Specifically, it has been observed that one of the 8 expansion joints located on the bridge was not correctly positioned. In other words, there was a too high and irregular displacement between the 2 faces of the joint. So, it was time to ask if the whole expansion joint had to be redone or the problem could be located elsewhere.
In order to understand what could it be happened, it was decided to put the expansion joint under control via two different methods: a classic topographical way and an innovative real time way. With respect to the first way, 2 reference points were placed across the joint. The space between the faces has been read 6 times with different outside temperature values. This work was also useful to the second because it had to calibrated. The real time monitoring consisted of 4 displacement sensors placed at the 4 ends of the bridge deck and 1 temperature sensor. The sensors read the displacements and temperature 6 times per day for a 6 months period. The data were collected in a central unit and it was possible to download them by a simple click on the computer desktop. In fact, an innovative GSM connection between the central unit and a remote one has been provided. This was the true "real time" monitoring as in every connection it was possible to read the sensors and to become aware of the passing of a car or a truck (excessive or low displacement). Finally, lots of data have been collected.
They have been first calibrated with the topographical survey and then correlated with the temperature sensor data with a normalization standard. Results showed that 3 over 4 sensor ends had an erratic behavior. So, it was demonstrated the problem was not located only on the expansion joint itself but also on the lower bearing devices of the bridge.

#141 The Calibration of Air Traffic Simulation Model
Elpidio Romano, University in Naples "Federico II"

Andrea Tocchetti, University in Naples "Federico II"
Michele Montecuollo, University in Naples "Federico II"

Synopsis

The increase of the flight operations and the demand to guarantee a suitable level of service it makes necessary both to foresee what the principals are "bottle necks " of the airport infrastructure, both to hypothesize some future scenarios where the infrastructure can increase his own question. The elevated number of the aleatory variable connected to the phenomenon has pushed to the use of the simulation models to foresee the development of the airport system seeking the maximum number of compatible operations with a scenery of hypothesized intervention. The application in the airport Naples-Capodichino has been performed with the Simmod, official simulator of FAA and EEC, defining the characteristics of the aerial traffic simulation system and individualizing the principal subsystems that represent it:

1. approach; 2. landing; 3. take-off; 4. leaving; 5. taxing.

The runways, the taxiways, the airport features and the airport stands have been reproduced analyzing the airport infrastructure.

This model has been inserted in the Simmod as initial scenery, inserting all the characteristics of the system. The management of the aircraft movement in arrival and in departure from the airport has been conducted implementing in the software the functions of drawn probcapacity to analyze the official fly schedule. They appears as the aleatory variable and it's important to know the laws of probcapacity. These last ones have been determined through the techniques of the statistic inference.

The statistic function has been implemented in the Simmod and it's used by the simulator to manage the aleatory events that are followed during the simulation.

Since the combination of arrivals and departures on an airport it's a aleatory variable, to get a stable result of simulation, we have performed thirty cycles of run, at the end of which it's drawn the average delay for flight operation. The inferred delays distribution curve and the theoretical function defined to real fly patterns, we have been checked with the statistic test . With a following validation, the Simmod can implement some statistic functions, characteristics of some real aircraft behaviours, that as default can be used in similar infrastructures.

#142 Research and definition of Car Accident Scenarios for Roadway Safety Managment of S.S. 372 "Telesina"

Grossi Rodolfo, Dipartimento di Ingegneria dei Trasporti "Luigi Tocchetti", Napoli (Italy)
de Riso di Carpinone Vittorio, Dipartimento di Ingegneria dei Trasporti "Luigi Tocchetti", Napoli (Italy)

Synopsis

The present paper has been developed on traffic, car accident and geometric data surveyed on the 61 kms of the italian rural road SS (Strada Statale) 372 "Telesina". The SS 372 starts from the motorway exit of Caianello, located on the Rome - Naples highway and ends in the town of Benevento. It has a variable cross section but in average it is about 9 m wide. The road alignment is typical of rural roads running in the hilly countryside of Campania region, southern Italy. The vertical alignment is made with several crests among upgrades but their values are lower than 3,5%; in the final part of the track heading Benevento there is just one 7% upgrade. All along the track there are many motorway exits made on different levels with small lenght acceleration and deceleration lanes.

Car accident data related to a 11 year period ranging from 1993 to 2003 have been collected and analysed from Police reports. The resulting database is made of about 180 accidents. The ANAS statistics on 3 sections of the road track have been collected too, being ANAS the Italian society deputed to the management of most part of rural roads. So, it has been possible to share the whole track in 3 parts. The ADT (Average Daily Traffic) has been supposed to be constant within each part of the road.

The preliminary general analyses done on the whole track showed not so high accident indexes. Nevertheless, the successive scenario research showed some specific matters.

First, a database of the road has been built. The database has been shared in three parts: 1) geometric data; 2) traffic data; 3) accident data. The first part has been built with the help of the existing topographic data: the whole track has been summarized with specific regard to horizontal and vertical alignment and location of motorway exits. The second part has been built on ANAS data as previously stated. The third part has been built on the police data. Accident location, traffic and road pavement conditions have been filed.

Finally, a matrix data in which the following quantities have been associated to every accident has been built: "heading (to Benevento or Caianello) of the car which caused the accident, extracted from part 3; light conditions (day or night) at the moment of the accident, extracted from part 3; road pavement conditions (wet or dry) at the moment of the accident, extracted from part 3; horizontal alignment (curve or tangent), vertical alignment (positive, negative or plan) in the area of the accident, extracted from part 1 and finally the sight distance of the point in which the car accident happened (yes or no) calculated with informations provided from parts 1 and 3. Part 2 data have been just used to share the road into three homogeneous traffic conditions. Not all components have been used to build scenarios. Finally, 96 different possible scenarios have been built. As soon as each scenario has been characterized on the temporal and spatial point of view their hazardousness has been evaluated with the accident index.
Results showed that all 3 most dangerous scenarios included the component "lack of passing sight distance". Details showed that the first and most dangerous scenario is made with the following components: "daytime, wet, curve, lack of passing sight distance"; the second one "daytime, dry, curve, lack of passing sight distance". So, it seems clear that the component "lack of passing sight distance" has a prevalent influence on the hazardousness of scenarios; in order to improve safety it should be necessary to work on this component for instance by enlarging the shoulders of the road or making adequate excavation in curve.

#143 Airport Risk Assessment. A Probabilistic Approach
Elpidio Romano, Department of Transportation Engineering "L. Tocchetti" - Naples

Synopsis

The purpose of this paper is to describe and analyse the problem of safety aspects at airports. Special attention is given to the following aspects: a strategic approach to improve airport safety, which includes the use of failure and hazard analysis techniques and fast time simulation modelling; safety of land side operations; certification aspects.
This research looks at an extremely small part of that network, picks out a few hazards, introduces a new modelling tools that have been used in their analysis, and discusses some mitigating strategies.
A risk is "the combination of the probability, or frequency, of occurrence of a defined hazard and the magnitude of the consequences of the occurrence". The air traffic control system is in place to monitor and maintain both vertical and horizontal separation; also, many aircraft have radar based collision avoidance systems installed.
The goals of risk assessment are: to derive the values of likelihood and severity of consequence for each hazard; to use that information as a means of prioritising actions, i.e. which hazard requires the most work and so should be tackled first?; to specify mitigating features as appropriate to each hazard; to predict the effectiveness of those features in reducing the risk.
To stand any chance of achieving these goals we first need a list hazards analyzing report of air accident or incident assembled in every Government from 1980 to 2003. We relived in the accident data that currently the general number of events in the world (accident, incident, serious incident) it is, for the commercial aviation, equal to around 50 a year, which correspond to in average 1300 deceased. The number of annual catastrophic accidents (accident) in the world it is, instead, around equal to 25. The model provides equations with which to determine either the impact or wreckage location of an aircraft following an accident. Several equations are described which cater for all permutations of: aircraft operation (approach or departure); crash from flight, or runway run off, veer off and, crash location (before or after the prepared runway surface). These equations form a set of probability distribution functions of a crash occurring per unit area. The probability of an aircraft being struck by debris due to an accident has five components. The product of these components gives the desired result: P(accident) or the proportion of aircraft within the airport vicinity that have an incident that causes it to crash, or run – off, veer – off, short land the runway; P(accident type) that represent the type of accident the aircraft will have (short landing, overrun, run off, veer off etc.). These components derive by the statistic analysis conduct beginning from real data deducted by accident reports; P(aircraft type) that represents the probability of an aircraft type occurs in an accident. This value is relate with actual and estimate number of aircraft operation, landing and take – off; P(point of occurrence) or the region that will be affected by the resulting crash or run – off; P(final point) that represent the region that will be affected by debris or the entire aircraft due to accident occurs in take – off or landing manoeuvres.

With this model we determine the region around airport that will be interested by the incident. In other words we determine the area affected by different probability occurrence of incident (frequency of occurrence of a defined hazard). To determine the risk we will be multiplied by the magnitude function that will be determine with reference to an accident and the operation of aircraft types.
The final product of this research will be a quantitative tool that can be utilized both in airport project and in the operation management, assessing in the first case an useful tool to the infrastructure realization of determinate capacity in the other case a “limit” to the airport capacity.

#144 Modeling Drivers’ Roundabout Behavior

Elpidio Romano, Dipartimento di Ingegneria dei Trasporti “L. Tocchetti” Università di Napoli “Federico II”

Synopsis

This work contributes to the development of microscopic traffic performance models in the roundabout. It enhances the existing models and develops new ones. An important contribution of this research is the empirical work, i.e. estimating models using statistically rigorous methods and microscopic data collected from real traffic.
To develop a roundabout simulation model it is necessary to examine drivers’ behavior. Therefore can be useful to define trajectory "type" from the entry up to the exit arms.
In this research it is been individualize the elementary drivers’ behavior that will characterize every trajectory (e/o manoeuvres), trying to determine a mathematical formalism (model) that reproducing them.
The connection among the models that reproduce different drivers’ roundabout behavior it will allow to simulate the manoeuvres according to the sequence: approach; circulation; lane changing to the lane inside; lane changing to the external lane; exit.
The purpose of this paper, in the approach manoeuvre, is to present a microscopic decision model for driver gap-acceptance behavior when waiting at an intersection on the secondary road. Critical gap is one of the major parameters for gap acceptance models. The accuracy of capacity estimation is mainly determined by the accuracy of the critical gap. This paper focuses on the implementation of the maximum likelihood technique to measure a driver's critical gap using field data. A methodology to define gap events is proposed, so that the accepted gaps and maximum rejected gaps required by the maximum likelihood technique could be obtained.
The model takes into account individual preferences by defining individual critical gap, which is different from the traditional macroscopic critical-gap approach. The latter estimates the critical gap for the entire population of drivers.
The acceleration model (reproducing some circulation behavior) defines two regimes of traffic flow: the car - following regime and the free -flow regime. In the car - following regime, a driver is assumed to follow his/her leader, while in the free - flow regime, a driver is assumed to try to attain his/her desired speed. A probabilistic model, that is based on a time headway threshold, is used to determine the regime the driver belongs to. Heterogeneity across drivers is captured through the headway threshold and reaction time distributions.
The parameters of the car - following and free - flow acceleration models along with the headway threshold and reaction time distributions are jointly estimated using the maximum likelihood estimation method.
The lane changing decision process is modeled as a sequence of three steps: decision to consider a lane change, choice of a target lane, and gap acceptance. Since acceptable gaps are hard to find in a heavily congested traffic, a forced merging model that captures forced lane changing behavior and courtesy yielding is developed. A discrete choice model framework is used to model the impact of the surrounding traffic environment and lane configuration on drivers' lane changing decision process.
The models are estimated using actual traffic data collected from Foggia and Naples roundabouts. In addition to assessing the model parameters from statistical and behavioral standpoints, the models are validated using a microscopic traffic simulator. Every model are implemented in Visual basic 6.0 language and next we are connected them in a single simulation model, implemented in Visual Basic language that reproduce circulation in the real roundabouts. This model is calibrated using real data collected in the Foggia and Naples reality and regards time spends in queue for every secondary street, gap acceptance behavior, speed in the circulation and capacity of two real roundabout intersection.
Overall, the empirical results are encouraging, and demonstrate the effectiveness of the modeling framework.

#146 Modelling Transport Corridors

Capon P., Longo G., Santorini F., Department of Civil Engineering - University of Trieste

Synopsis

The paper deals with transport demand modelling and provides an overview of common methodological approaches to the estimation of traffic demand within the strategic analysis of transportation corridors.
Economic evaluation of transport systems is built on consolidated modeling approaches. Within this framework, demand estimation and forecasting are essential tasks, which are performed through the definition of suitable models able to predict users' behaviour and response to changes in transport services and/or infrastructures.
The most common model for travel demand forecasting is the so called "four-stage model", which divides the multidimensional choice into four levels: choice of travelling for a stated purpose (emission or frequency models), choice of destination (distribution models), choice of mode (modal split models) and choice of route (path choice models).
In the paper an example of a "four-stages model" is presented and discussed with reference to a transport corridor planning study: the estimation of freight and passengers' flows in the case of the realization of a new high-capacity railway between Venice and Ljubljana, which should perform the necessary connection between the E.U. Corridor n°6 (Lyon, Torino, Venezia, Trieste), identified by the Essen Conference, and the 5th Pan European priority Corridor (Trieste, Ljubljana, Budapest, Kiev) as defined in the Crete Conference.
In order to carry out the evaluation of this new transalpine rail crossing, a transportation study has been carried out which included the estimation and prediction of traffic flows on rail and road networks. A demand and supply analysis has been carried out; Origin/Destination matrices have been provided both for passengers and freight transportation and different graphs have been realised for rail and road networks. Then generation, distribution, modal choice and assignment models have been calibrated.
In the paper some important modelling issues are discussed, which are relevant in corridor planning processes, and finally some remarks are presented about the coherence between predicted traffic flows and the transport system capacity in the design scenario.

#148 European standards on construction materials and highly environment-consistent road techniques: experimental research on soil stabilization with lime.

Nigrelli J. University of Palermo

Synopsis

It is well-known that the clayey materials non-stabilised cannot be used for constituting road subgrades, embankments or subbase courses. Because their important fine part content and their strong plasticity make them too much sensitive to water action and so they are exposed to high reduction of bearing capacity.
Increasingly stricter restrictions on digging out of suitable natural material for the realisation of road embankments, together with problems related to the disposal of excavation soils, make it necessary to reconsider, in the field of material realisation methods, those soil stabilization techniques which have been long known and applied. More specifically, stabilization with lime has a strong environmental significance, because it allows to re-use extremely plastic clays which, even in those yards where considerable quantities of soil are moved, would be conveyed to dumps and cause the heavy well-known consequences on the environment. Furthermore, the CE marking of construction limes, compulsory in Europe since 1 August 2003, fixes their characterisation and filing according to harmonised technical specifications, making it possible to have different kinds of lime with different characteristics and costs. We may then wonder if effects on the soil to be stabilized are different too, because that would imply carrying out a relevant costs-benefits analysis before choosing the more suitable type of lime. Such assumptions were the starting point for an experimental research on the effects produced by some kinds of lime on clayey soils within a stabilization process. The properties of the "lime" product, which are partly marking-certified, have been reverified in laboratory in compliance with test methods provided for by harmonised reference standards; the stabilization process effects have instead been estimated through typical tests on soils, such as the determination of the standard Proctor compactation curve and of the immediate and post-saturation CBR.
The experimentation has shown that, in the same conditions, different kind of lime produce results sensitively diverse and that the non-controlled lime has not the same effectiveness as the CE markable one.

As well, in the application of the stabilization technique it is needed to fix in the Tenders the marked products. And it is necessary to assess the effects achieved from different classes binders thanks to pilot studies.

#149 A Microsimulation Traffic Model to Estimate Accidents due to Reduced Sight Distance

Mariano Pernetti, Second University of Naples

Synopsis

The sight distance available on existing roads is very often lower than the stopping sight distance needed to avoid the collision with standing obstacles in the travelled way. When this occurs many rear-end crashes can happen because each follower could not see his/her leader. The investments needed to increase the sight distance to the value arising from the actual speed of the vehicles are usually very high. Due to budget constraints road agencies have to select the road segments to improve by estimating their safety performance. This activity is not an easy task. The most useful approach to address this type of problem is to use a microsimulation traffic model, which has to consider roadway configuration, sight distance, roadway surface condition, braking lights, human behaviour, etc. With this type of tool it would be possible to define the number of collisions or loosing control vehicles, their corresponding speed, the number of vehicle at collision “risk” in the queue, etc.

In this paper the structure of a microsimulation model tacking into account most of the influencing factors is presented. It has been conceived with the aim to reproduce what happens in situations where the sight distance is reduced.

The first part of the paper concerns the description of the modules in which the model is organized. The second part presents an application to a road segment where a standing obstacle exists in a curve and the sight distance is limited by a retaining wall. This situation has been compared with a similar road segment where the sight distance complies with the Italian Standard.

The results obtained show the higher is the flow rate the lower are the rear-end crashes and loosing control vehicles. This is due to the fact that for high flow rate the vehicles are slower and a very high interaction exists among them, so that the braking lights of the leaders suggest to the followers to adopt a prudential behaviour.

#150 Bituminous Mixtures Simulation With Distinct Particle Elements Method

Dondi G., University of Bologna – DISTART Strade
Bragaglia M., University of Bologna – DISTART Strade
Vignali V., University of Bologna – DISTART Strade

Synopsis

This paper investigates the use of Distinct Particle Elements Method (DEM) to simulate the behaviour of a bituminous mixture in a Marshall test.

To investigate the effect of particles number on material properties two different specimen generation procedures have been implemented: the up-scaling technique, that allows to enlarge the particles diameter with a great reduction of their number and consequently of the computational times, and the cluster logic, that allows to schematize aggregates with group of particles of arbitrary shape that are physically bonded together.

For each test the stability-flow curve and the stresses in the specimen have been investigated.

To point out DEM particular features in performance related modelling of asphalt concrete tests, the laboratory results have been reproduced also with a finite difference code.

#151 Driver Behaviour At Urban Intersections

Leonardo Bruno – DIIV – University of Palermo
Angela Rizzo – DIIV – University of Palermo

Synopsis

The drivers of vehicles approaching an urban road intersection have to regulate their vehicle velocity in order to make their manoeuvre safely. This regulation depends also on the presence or not of eventual obstacles to a reciprocal and clear sighting of vehicles which belong to different streams.

In urban ambit, the presence of not eliminable obstacles to visibility causes inevitable slowing down even for the vehicles that have the right of way. Referring to an intersection whose circulating scheme is quite common in Palermo's city center (intersection of 4 branches with a one way circulation), the kinematical relations that justify the slowing down of the vehicles are recalled in the first part of this work.
Using these relations we can also demonstrates that the vehicles which go along the minor road must completely stop before being able to make their crossing manoeuvre. To verify the conclusions which derive from kinematics and only for the vehicles that have the right of way, an experimental research plan, aimed to find the characteristics of the motion of the vehicles in proximity to the studied intersections, has been prepared in advance.
After having described in brief the instruments mounted on an appropriately equipped vehicle, the processing steps necessary to reconstruct the velocity and acceleration trend are reproduced. In the end, the parameter values that have to be put in the kinematical equations and that, considering the experimental results obtained, better describe the real behaviour of the drivers close to the road intersections are proposed.

#152 Design Of Flexible Pavement Layers

Jan Jähnig, Alexander Kiehne, Christiane Weise, Frohmut Wellner, Dresden University of Technology, Germany

Synopsis

Several research projects realized by the Chair of Pavement Engineering at the Dresden University of Technology aim at the development of an analytical design method comprising a multitude of factors effecting the pavement condition. The stress and strain behaviour of a pavement can be predicted or the remaining life cycle of the pavement structure is calculated by means of such a method. These advantages are especially important regarding warranty claims. The developed dimensioning model is based on the fundamental idea of freely choosing any possible construction (flexible pavement). In this way a particular pavement structure can be set depending on layer thickness and layer material. Furthermore the dimensioning model aims at the optimisation of the pavement construction considering traffic loading and weather-induced factors. Using different materials the particular thickness of each layer is optimised on the basis of failure hypotheses. The described approach is illustrated by a calculation comparing various constructions and examining separately cracking and rutting as the two main reasons for material failure.
On the basis of the calculation example relevant influence parameters (layer thickness, resilient modulus of unbound base layers, material composition) are determined and the general feasibility of the method is shown. The calculation results exhibit a suitable first approximation considering all simplifications made during the approach. In the first place the results are used for a qualitative evaluation of the described parameters.
Additionally the article gives a short overview of the current research work at the Chair of Pavement Engineering at the Dresden University of Technology especially about the research project "Sustainable Development of Pavements", which was funded by the German Federal Ministry of Education and Research. The determination of material laws for asphalt layers on the basis of dynamic triaxial tests and the calculation and prognosis of cracking and rutting with the finite element method are the main content of this research project. The Chair of Pavement Engineering of the Dresden University of Technology realizes this research project in cooperation with the Institute of Pavement Engineering and Road Design of the Technical University at Brunswick and the German Federal Highway Research Institute. First results will be presented.

#153 Evaluation and Measurement of a quality index for existing roads

Cafiso, S. Di Graziano, A. La Cava, G., Department of Civil and Environmental Engineering, University of Catania, Catania, Italy

Synopsis

The measurement of the road serviceability, respect to use and management needs, is strictly connected with the definition of road performance indices. In this way the state of knowledge evidences several performance indices related to many measurement parameters of road characteristics and operations. In this paper, starting from current experiences in the state of art, five reference criteria of the road performance index were identified: Safety, Comfort, Services, Environment and Usefulness. It was then defined a procedure based on the MultiCriteria Analysis (MCA) in order to combine these five criteria to obtain an unique value named Quality

Index (QI), able to evaluate the overall serviceability level of the road. By structuring a problem within the MCA framework, alternatives may be ranked according to preestablished preferences in order to achieve preestablished goals. Specifically, the AHP method (Analytic Hierarchy Process) is based on the definition of a two(or more) dimensional matrix, where one dimension expresses the various alternatives and the other dimensions refer to the criteria by which the alternatives should be evaluated.
The procedure was implemented taking into consideration two lane rural roads infrastructural typology which represent the largest part of the network and carry a considerable share of traffic mobility. However, this type of roads has often been neglected in terms of the quality required, because of both the greater inertia of local agencies and the current lack of complete and updated road data. In this way the parameters of the above mentioned five criteria and their evaluation models suitable for the specific application were identified. The definition of the QI is, also, linked to the typology of road characteristics data survey which must coming from an high speed system. In this field it was fundamental the use of the Mobile Laboratory of the Department of Civil and Environmental Engineering, which allows to accurately collect the main part of the required information related to the infrastructural features locating them along the road. During data postprocessing, the location along the road of the surveyed information allows to deduct the performance index and permits a direct evaluation of the serviceability quality offered by the road. The experimental application on a two lane rural road allowed to check the feasibility and the capacity of the proposed methodology based on the model and on the information acquired during the survey. In such a way the procedure defines a system of direct use and application for road local agencies

#155 Repeatability of Interlayer Shear Resistance determined with Two Test Procedures

Canestrari Francesco - Istituto di Idraulica e Infrastrutture Viarie - Università Politecnica delle Marche
Ferrotti Gilda , Istituto di Idraulica e Infrastrutture Viarie - Università Politecnica delle Marche
Partl Manfred N., Department Materials and Systems for Civil Engineering Swiss Federal Laboratories for Materials Testing and Research (EMPA)
Santagata Felice A., Istituto di Idraulica e Infrastrutture Viarie - Università Politecnica delle Marche

Synopsis

Interlayer bonding significantly influences the performance of multi-layered pavement systems. To correctly know how this bonding modifies the interlayer mechanical performance, theoretical and experimental projects are currently in progress in many countries. However, different equipments generally provide different results because these results are obtained under different test conditions in terms of applied stress and strain, rate of displacement, specimen size and specimen confinement. Since in European Standards there is a normative gap regarding interlayer resistance tests, in Italy a draft of a standard is currently under development based on a laboratory direct shear device called ASTRA (Ancona Shear Testing Research and Analysis). In the present paper, the repeatability of ASTRA test method is studied by analyzing the results obtained in two experimental investigations. In the first investigation, specimens prepared with the same material and the same compactor were tested with ASTRA test method and with another shear test method, the LPDS (Layer-Parallel Direct Shear), which is compatible with Swiss Standards (Schweizer Norm SN 671961, 2000). In the second investigation, the first series of ASTRA results were compared with repeatability results obtained by using different materials and different compaction methods for the double-layered specimens. The study shows that the two shear test equipments provide the same precision level in terms of scatter of the results. Moreover, the ASTRA investigation shows that the repeatability depends not only on the test method but also on the pavement material and compaction method. This study allows supporting Italian standardization of interlayer shear resistance testing and, at the same time, it shows that it is necessary to further investigate different materials and different compaction methods to improve the knowledge on repeatability.

#157 Transport reform in Italy and the case study of Bari

Elisabetta Venezia, Dipartimento di scienze economiche – Università degli studi di Bari

Synopsis

At present, the structural reform of the Italian local public transport is aimed at a potential re-launching of the sector which should make the engaged resources more productive, and, at the same time, at the achievement of

more general objectives linked to sustainable mobility, such as accident prevention measures, environmental protection, urban life quality and international market competitiveness.
Nevertheless, currently there is a limited true competition existing in the transport market and in many cases, especially in Italy, incumbents are the winners of the new tender procedures. Additionally, recent, changes in the legislation on local public services allow the assignment of transport services "in house". This means that tendering procedures will no longer be compulsory. The consequence is that some local bodies have cancelled tendering procedures and some others have immediately assigned the service to the previous public operators. This is the case of Bari, which will be examined in depth. The effect is an increase in deficits, due to high level of wages unjustified by low productivity, and the complete thwarting of 8 years of work.
Nonetheless, it is advisable to consider users' needs because they have changed and are strongly sensitive to the supplied quality service and to problems of urban life enjoyment and environmental sustainability. In this context, therefore, it could be useful to investigate a city like Bari - a southern Italian city strongly drawn to cars - with a twofold aim. On the one hand, the current supply of public transport – as perceived by users -, which is offered by local operators, is examined and, on the other hand, mobility needs and population behaviour in Bari and of those who use urban transport in Bari are studied. The idea behind this study is to overcome the crucial impediment in understanding urban travel patterns and the forces behind user attitudes which normally characterise city surveys. These surveys normally have demonstrated that urban travel data are insufficient in both quality and quantity, and are often not available in useful form. Nonetheless, the importance of attitudinal data in the transport literature has long been established, although understanding the facts that affect transport choice is not such an easy task.
It is important to point out that survey results should be read by taking into account the current national situation and the consequent demand and supply of urban collective transport. In particular, in many small and medium-sized cities, as for transport demand of daily flows due to study and labour reasons, it should be considered that there is a growing use of private cars and a progressive increase in systematic mobility. As for supply, the continuous worsening of traffic conditions on urban road networks and the presence of negative external economies which strongly penalise collective transport in terms of organisation and quality should be considered.
This paper ends with the presentation of some empirical results stemming from the estimation of a random utility model. The individual's utility of two choices – bus transit and private means – is estimated by binary logistic regression and logistic regression coefficients which are used to estimate odds ratios for each independent variable in the model. The value assumed by the dependent variable, as the probability to use buses, is equal to one. All the values assumed by independent variables have been transformed into dummy variables in order to capture each characteristic of independent variables represented by sex, occupational status and so on. Thus, based on a survey of 1886 respondents, the main findings are that notwithstanding the existence of a mediocre transport urban service, people would be in favour of using buses in the future. But this shift towards public transport needs to be encouraged through appropriate policies which could culminate in the achievement of a greater sustainability, otherwise we will most certainly have a difficult future characterised by higher car ownership and car usage.

#157 Investigation Of The Procedure To Determine Asphalt Binder Viscosity In The New AASHTO Pavement Design Guide

Clara Celauro, DIIV - Dipartimento di Ingegneria delle Infrastrutture Viarie, Universita' di Palermo, ITALY
Mihai Marasteanu, Department of Civil Engineering, University of Minnesota
Noa Funk, Department of Civil Engineering, University of Minnesota
Roger Olson, Minnesota Department of Transportation, Office of Materials and Road Research

Synopsis

The dynamic modulus of asphalt concrete is the critical parameter in the new AASHTO Design Guide for the construction of new asphalt pavements in the United States; it directly controls the prediction of asphalt pavement performance with respect to rutting and fatigue cracking. Levels 2 and 3 of the AASHTO Pavement Design do not require the expensive and time consuming testing of the asphalt mixture; instead, they rely on an empirical predictive equation that calculates the asphalt mixture modulus based on the aggregate gradation and the asphalt binder viscosity.

The current asphalt binder specifications provide a direct method for measuring the viscosity only at mixing and compaction temperatures. Presently, there is no accepted method to determine the viscosity at temperatures corresponding to rutting and fatigue cracking. The Design Guide uses empirical equations to calculate the viscosity from DSR binder data and to predict the viscosity-temperature relations. This paper investigates how well these empirical relations work and what are the implications in predicting the complex modulus of the asphalt mixture using these equations. Recommendations are made with respect to improving the asphalt mixture modulus prediction from asphalt binder data.

#160 A Rational Approach for the Evaluation of Pavement Pay Factors

Mauro D'Apuzzo, Dept. of Mechanics, Structures & Environment, University of Cassino, Italy
Marco Mattarocci, Dept. of Transportation Engineering, University of Naples "Federico II", Italy
Vittorio Nicolosi, Dept. of Civil Engineering, Second University of Rome "Tor Vergata", Italy.
Mariano Pernetti, Dept. of Civil Engineering, Second University of Naples, Italy.

Synopsis

Most of Italian road superstructures are of semi-rigid and flexible type. Despite their widespread use, hot mix asphalt construction specifications and quality control / quality assurance testing plans, when employed, are still based on an empirical approach. Bituminous mixes not complying with specification are rejected or accepted with a price reduction (penalty) that is not based on the real performance and therefore it does not allow a rigorous life cycle cost analysis. In this paper a new methodology for the evaluation of pavement pay factor evaluation is presented. The methodology is based on a performance related approach. The core of the methodology is represented by a mechanistic empirical pavement design procedure that is employed in order to estimate pavement performance both in the "as design" and in "as built" condition. The pavement design procedure allows to evaluate pavement fatigue life and maximum rut depth as a function of bituminous mix properties, pavement layout, on site prevailing traffic and climatic conditions.
Because of variability of bituminous mix properties due to, on one hand, the acceptance ranges reported in hot mix asphalt specifications and, on the other hand, in-situ mix production and laying operating conditions, a constrained Monte Carlo simulation, by means of an Latin Hypercube Algorithm, has been carried out in order to evaluate pavement performance.
Following this stage, a criterion based on a Life Cycle Cost Analysis (LCCA) concept has been employed in order to evaluate the Payment Adjustment Factor (PF) to be applied to the Contractor as a function of the pavement performance in the as-built scenario as compared with that pertaining the as-design scenario.
Basing on a typical pavement specification framework adopted in Italy, a case study has been examined and a regression model has been developed on data generated in the Monte Carlo simulation, in order to derive a Pay Factor prediction expression as a function of the normal deviates of relevant asphalt concrete properties affecting pavement performance.
Preliminary results seem to indicate that this approach may be useful both in the design stage, in order to take into account the pavement performance reliability, and in the construction stage, as a reference for the contractor to allow the production and the laying of high quality bituminous mixtures.

#162 Resistance to polishing and mechanical properties of aggregates for asphalt concrete wearing courses

Lancieri F., Department of Civil Engineering - University of Pisa
Losa M., Department of Civil Engineering - University of Pisa
Marradi A., Department of Civil Engineering - University of Pisa

Synopsis

The durability of skid resistance properties of pavements is considerably dependent on the polish–wear characteristics of aggregates. As a road surface comes into contact with the vehicle tyre under repeated traffic movements, the exposed aggregates will experience a wearing or abrasive effect. This effect is accelerated by the presence of sand or grit on the road surface. If aggregates are of a particular nature, the gradual wearing will result in a loss of aggregate angularity and polishing may occur. If this happens, the overall skid resistance of the road surface decreases. Aggregates selected for use in road surface mixes must be able to withstand

repeated heavy loads without undue polish/wear; certain aggregates in road surfaces are more susceptible to wear and polish effects than others, becoming extremely slippery when wet.
In this paper, the Authors present the results of laboratory tests on physical, mineralogical and mechanical properties of aggregates currently used in Tuscany for hot mix asphalt wearing courses. The aim is to evaluate relationships between empirical characterization of aggregates (Los Angeles Abrasion Test LA, Fragmentation Coefficient FC, Aggregate Abrasion Value AAV) and friction performance of pavements, as related to changes in microtexture, simulated by using the Accelerated Polishing Device; the analysis takes into account the aggregate shape and flakiness index as well as mineralogical properties determined by a petrographic analysis. Results of aggregate performance tests, with regard to the decrease of pavement skid resistance, combined with empirical tests and mineralogical properties, can suggest new specifications for aggregate parameters; by using the results of aggregate wear-polish characteristics, it seems reasonable to accept lower limits for the aggregate parameters determined by using empirical tests.

#163 Analysis of the technical parameters for the determination of Road User Costs for planning and management of road infrastructures

Giacomo Tuffanelli , Transport Planner, JMP Consulting
Marco Zavattero

Synopsis

Road user costs are one of the components of the total road transport costs, which have a primary importance when carrying out an economic appraisal of investments in road construction or rehabilitation projects.
Road investment appraisal models simulate the interrelationships between the environment, construction standards, maintenance standards, geometric standards and road user costs. Modification to road condition or to the geometric standards of the road have a direct effect on vehicle speeds and the costs of vehicle operations, as well as accident rates on the road. The costs that the community has to bear because of these modifications can be evaluated through road user costs models.
The models used in the HDM-4 (Highway Development & Management, World Bank, 2001) seem to better represent the relationships existing between road condition and geometric standards of the road and road user costs. A mechanistic/behavioural model is used to calculate the average vehicle operating speed of a section of the road as a function of road characteristics, vehicle characteristics and traffic flow levels
The aim of the present study is to provide an expression to calculate the average vehicle operating speed as a function of a reduced number of factors such as road curvature, surface roughness, gradient, etc. and that refers to the Italian reality.
The equations the HDM-4 provides to calculate the average vehicle operating speed have been calibrated to reflect the Italian trends. These equations have then been combined together, also using statistical tools, to obtain a single expression for the average vehicle operating speed. This expression is valid as long as the independent variables that had been chosen as such are included in set intervals.
Travel time can then be easily calculated once the average vehicle operating speed is known. Its definition and value is decisive to determine travel time costs that are probably the most consistent part of road user costs and they play a significant role in road investment appraisals. Therefore, an approximate estimation of road user costs could be easily achieved and may be used as an indication to assist with the selection of the appropriate projects when a wide range of alternatives is available.

#167 Integrating environmental and traffic performance variables in urban road-network project assessment. An explorative study.

Granà A., D.I.I.V. – Dipartimento di Ingegneria delle Infrastrutture Viarie - Università di Palermo
Giuffrè T. , DIIAR – Sez. Infrastrutture Viarie - Politecnico di Milano

Synopsis

More often and more often, besides improvements in traffic efficiency conditions (increase in average running speed), urban road-network projects are directed towards accident reduction and, more in general, towards the protection of the public safety through measures suitable to bring down environmental pollution levels (particularly air pollution) within tolerableness limits in relation to the context vulnerability.

In spite of this, whereas it's possible to carry out easily the comparison between different project options as regards those matters concerning urban traffic efficiency (for example, through analitical/deterministic methodologies already for a long time tested such as HCM procedures), the road designer work becomes uncertain when improvements obtainable in terms of reduction in pollutant emissions have to be evaluated. That's why pollutant emissions depend on characteristics of vehicles in traffic flow and on road operating conditions that are predictable after the implementation of the road project and the usual emission factor/rate models do not reflect reasonably on the on-road vehicles emissions of modal traffic events, such as those ones occurring at intersections.
It has seemed suitable to start a research program for defining a decision making tool to evaluate the effectiveness of urban road-network projects accounting for effects on efficiency of road traffic and on risk joined to pollutant emissions. In this way, considering the close relation between emission phenomena and the instantaneous characteristics of road traffic, a specific research has been devoted to model and to measure vehicle pollutant emissions in different situations (for geometry and traffic), typical in urban areas.
This paper reports the results of a first exploratory analysis, based on realistic driving patterns, directed towards the definition of driving cycles typical of intersection situations. The correlation between usual efficiency parameters (control delay, queue lenght, etc) and the emission level have been also explored.

#171 A New Approach to the Mix Design of Bituminous Mixtures for Trench Sealing
Ezio Santagata, Politecnico di Torino, Torino, Italy
Emanuele Toraldo, Politecnico di Milano, Milano, Italy
Synopsis
Research in the area of bituminous mixtures for paving applications has lead to an improvement in the understanding of the mechanisms which control their performance in the field. The importance of aggregate structure, bitumen-filler mastic and of aggregate-bitumen interactions has been highlighted, spurring the development of function-specific mixtures for special applications.
In such a context the Authors have pursued the mix design of bituminous mixtures to be used for the sealing of narrow cuts in pavement surfaces. This specific need has arisen in a research project focused on the development of materials for the implementation of a new technology for the laying of underground telecommunication cables.
The aims of the mix design method described in this paper are the obtainment of mixtures characterized by an appropriate balance of workability, stiffness and shear resistance. In fact, a high level of workability is essential for the complete filling of the surface portion of the trench, while stiffness and shear resistance are needed to prevent post-compaction permanent deformation and lateral flow. Based on these requirements, the Authors decided to consider for design a hot-mixed bituminous material containing a single-sized aggregate (5/10 mm) and a filler-bitumen mastic obtained from the combination of a standard bitumen (70/100 pen) and cement filler.
The proposed design procedure was structured in five successive phases. In the first phase, the base materials (aggregate, binder and filler) were selected and characterized according to existing standards. These operations were followed by the experimental evaluation of the filler-bitumen ratio to adopt for the constitution of the bituminous mastic, performed in phase two. The third phase of design was dedicated to the definition of the aggregate-mastic ratios to use in the calculation of the mixture recipes. Finally, in the fourth and fifth phases of design the selected sealing mixtures were prepared in the laboratory and subjected to volumetric and mechanical tests.
Testing of the mastics, carried out on materials with a variable filler-bitumen ratio, was carried out by performing ductility tests at 25°C and direct tension tests in the low temperature range (0 and -6°C). Two filler-bitumen ratios, equal to 2.0 and 2.5, were subsequently selected for the preparation of the design sealing mixtures since they ensure a satisfactory balance in terms of strength and ductility.
The target mastic-aggregate ratio was established by modeling the structure of the mixture as a single-sized system saturated by bituminous mastic. The voids available in the aggregate structure for saturation were assessed by performing compaction tests on the aggregate by means of a gyratory shear compactor, for which a specific testing protocol was developed. The compaction properties of the corresponding design mixtures, the recipes of which were derived by means of volume-weight conversion, were thereafter studied for both the

selected mastics. It was observed that the sealing mixtures have an acceptable residual void content (3.40-3.85%) which should ensure an adequate level of impermeability.
The mechanical characterization of the sealing mixtures was carried out in two stages in which the effects caused by variations of level of compaction, mastic composition and temperature were assessed. This was done by making use of standard test methods (elastic stiffness and indirect tensile strength) and of mechanistic-based characterization procedures (simple compression and direct tension) specifically developed by the Authors. The obtained results were coherent with expectations since stiffness and strength (in all the three modes considered) tend to increase as the mixture is compacted to a denser state and/or as the filling mastic is stiffened (either by increasing the filler-bitumen ratio or by reducing temperature). These same effects are generally accompanied by a certain degree of embrittlement which in extreme cases may limit mechanical performance.
The results obtained in the investigation support the conclusion that the mix design method proposed by the Authors is suited for the analysis of the specific kind of mixtures used for trench sealing. However, since stiffer mixtures exhibit brittle failure at lower temperatures, it is recommended that the choice of the design recipe to adopt in practice should also take into account the climatic conditions expected in service. Further improvements to the design method may also stem from the monitoring of actual field performance in order to develop acceptance criteria which may be included in technical specifications.

#172 Experimental Evaluation of Modified Bituminous Binders for Heavy Duty Applications
Ezio Santagata, Politecnico di Torino
Orazio Baglieri, Politecnico di Torino
Synopsis
As a result of their superior performancerelated properties, modified bituminous binders are increasingly being used in paving applications, especially in the case of pavements subjected to intense traffic flow with a high percentage of heavy vehicles. Experimental procedures and technical specifications used for such binders have to be necessarily based on a rheological approach by means of which their contribution to the overall pavement response can be assessed. One of the most advanced methods currently adopted in Italy for the characterization and acceptance of modified bituminous binders for heavy duty applications has been developed by Autostrade per l'Italia S.p.A. , the Road Agency which manages and maintains most of the Italian motorway network. Technical specifications, used for quality control purposes during construction and maintenance, have recently been integrated by a preliminary qualification system which involves a more detailed evaluation of the binders by means of empirical tests, rheological measurements and tests carried out on a reference bituminous mixture. In this paper the Authors present the results of an experimental investigation which was carried out with the purpose of evaluating the rheological properties of four different modified binders which were obtained from the use of three different SBS elastomers and one EVA plastomer. These were added to a single base bitumen in the same percentage (6%), typical of heavy duty paving applications. The experimental program included most of the laboratory tests indicated in the S.A. acceptance system: however, additional investigations were carried out in order to gather further information related to the expected performance of the binders. Experimental results indicate that the rheological behaviour of modified binders is strongly dependent upon polymer type. This was observed by analysing the results obtained in all testing configurations (coneplate shear and beam bending) and modes (oscillatory and creep) in a wide range of temperatures and loading times (or frequencies). The effects associated to the tough and rigid EVA matrix were highlighted at intermediate to low temperatures especially when loads were applied for short time durations and/or high frequencies: in such conditions these binders exhibited a stiffer and more elastic response than SBSmodified materials. This was observed both in rheological tests and in tests carried out on reference mixtures. As expected, plastomer stiffening effects were observed to be greatly reduced at higher temperatures and/or when approaching flow conditions, where binders containing SBS elastomers proved to be stiffer and more elastic, with a greater potential in contributing to permanent deformation resistance. Further differences in the response of the plastomer and elastomer modified binders were detected by analysing Black diagrams and creeprecovery curves. It was shown that different shapes are associated to different mechanisms with which the polymer matrix contributes to the overall response of the binder. It was thus proven that the use of these graphical representations can be useful in the interpretation of viscoelastic data. Test results were also analysed in order to evaluate the effects caused by variations of the composition (styrene content) and structure (radial or linear) of

the SBS polymer. In most testing conditions increases of the stiffness and elasticity of the binder were associated, especially in the intermediate to high temperature range, to increases of the styrene content, which affects the volume of the corresponding rigid domains created within the rubbery polymer network. The results obtained in the experimental investigation allowed the Authors to critically analyse the contents of the S.A. preliminary qualification system. It was concluded that the system requires to be carefully finetuned in order to make set requirements fully compatible with each other or, as an alternative, in order to establish a hierarchy among them. Improvements to the system may stem, in the future, from the introduction of additional rheological tests such as those described in this paper, from the analysis of a wide database of test results, from the harmonization of the specification approach with other validated systems (such as SUPERPAVE) and from the observation of actual field performance.

#176 Improved Traffic Signal Warrants for Crash Avoidance at Intersections

Flávio Cunto, University of Waterloo
Frank F. Saccomanno, University of Waterloo

Synopsis

In many jurisdictions, over 40% of all road crashes take place at or near intersections. One of the ways planners attempt to reduce the number and severity of crashes at intersections is to install traffic signals. Traffic signals seek to improve the flow of vehicles by reducing potential traffic conflicts and associated crashes. Manual on Uniform Traffic Control Devices warrants cite lack of safety as an overriding concern for the introduction on signals at intersections. Lack of safety is expressed in terms of the number of crashes reported by police at or near the intersection over a given period of time for a given volume of traffic. The fundamental problem with using historical crash occurrence to justify the introduction of traffic signals is that this approach ignores the rare random nature of crashes. Basically, what took place last year may not be a good indicator of what is likely to take place in the immediate future. The approach also ignores “near misses”. Given the practical need for consistency, the existing warrant structure needs to be modified to make it less dependent on historical crash variations and more reflective of potential “unsafe” conditions faced by drivers at a given location with and without signalization. The use of microscopic traffic simulation over the last two decades has essentially focused on the analysis of system transportation efficiency such as signalized intersections, arterial networks and freeway corridors. The potential of microscopic simulation in traffic safety and traffic conflict analysis became to be investigated more frequently since the beginning of 2000. This paper introduces a microlevel behavioural model to estimate crash potential at intersections for different traffic scenarios and geometric attributes. The model has been applied to a simple left turn movement for a fourleg unsignalized intersection. For this situation, increases in driver perception and reaction times and reduction in the pavement surface friction were found to increase crash potential significantly. The paper speculates on how the model can be used to provide insights into crash reductions causes by signalization.

#177 Performance Analysis of Mixtures Produced Using Foamed Bitumen

Bocci Maurizio, Istituto di Idraulica e Infrastrutture Viarie – Università Politecnica delle Marche
Cardone Fabrizio, Istituto di Idraulica e Infrastrutture Viarie – Università Politecnica delle Marche
Cerni Gianluca, Dipartimento di Ingegneria Civile e Ambientale – Università degli Studi di Perugia
Virgili Amedeo, Istituto di Idraulica e Infrastrutture Viarie – Università Politecnica delle Marche

Synopsis

The decreasing availability of aggregates and the large amount of aggregates needed for the construction and maintenance of infrastructures, have forced research staff, in Italy and in other countries, to seek alternative materials for road constructions. Presently, the use of recycled material becomes thus the key to more efficient and economical road construction. Currently, cold recycling technique presents major advantages due to minimum environmental and energy costs.
In particular, this research involves foamed asphalt process as a possible technique for the cold recycling of flexible pavements. The main task of this work is to investigate the potentiality of foamed asphalt treated mix as a base course material. The work was carried out performing indirect tensile stiffness modulus and fatigue tests

on cylindrical specimens prepared with different percentages of cement (1-3%) and foamed asphalt binder (2-4%). Test results showed that the changes in cement and foamed bitumen content resulted in a variation of the mechanical performance of the mix regarding its stiffness properties and fatigue resistance. In particular, the obtained results allow to state that only the choice of a correct bitumen-cement ratio ensures better performance concerning both the stiffness and fatigue properties and there is no univocal relationship between the stiffness properties and fatigue resistance performance regarding the investigated mixtures.

#179 Evaluation of road service levels through the software GLS2004.xls

Pasquale Colonna, Dept. of Highways and Transportation - Polytechnic University of Bari, Italy
Manuela Maizza, Dept. of Highways and Transportation - Polytechnic University of Bari, Italy
Simona d'Amoja, Dept. of Highways and Transportation - Polytechnic University of Bari, Italy
Vittorio Ranieri, Dept. of Highways and Transportation - Polytechnic University of Bari, Italy

Synopsis

In the choices regarding roads, there is more and more the necessity to specify parameters which define the road service quality considering all points of view: user, owner/manager and external community.
As a consequence, we defined a procedure based on a model that, through the evaluation of 54 significant elements, defined "indicators" of the road service, succeeded in associating to every road section a single synthetic parameter, expression of the quality of road service offered, called Global Level of Service – GLS. These procedure takes account of all the parameters involved with the right weight.
The Global Level of Service, with its structure, is a very versatile tool, that, with the aid of Geographical Information System, enables to reach the following aims:
- in operation phase, it enables to start the procedures of planned maintenance and management, identifying the priority of operations;
- in design phase, the GLS method with GIS use becomes a necessary tool to make choices, helping in identifying the best design option;
- in driving phase, it gives the users a tool giving informations about route, after having decided an origin, a destination and the time of departure, according to priority scales which favour different indicators according to personal needs (travel time, comfort, landscape, etc….).
The single indicators' algorithms and the GLS algorithm have been implemented in a software called GLS2004.xls which allows the user a fast input of the indicator's values during survey phase and an easy execution of the operations required by the procedure.
So, GLS2004.xls was created in order to computerize the procedure able to determine the GLS of each road section considered as a part of the road network of our interest.
This software was subsequently applied to a road network in the northern part of Bari district having the towns of Bisceglie, Molfetta, Terlizzi, Ruvo and Corato as vertices. The network was classified from a functional point of view and it was created a Geographical Information System which enabled to analyse results and to value the efficiency of the proposed methodology.

#181 Structure of Mobility Phenomenon: Outcomes of an Exploratory Analysis with Techniques of Non-linear Multivariate Analysis

Pasquale Colonna, Department of Highways and Transportation, Politecnico di Bari
Simona d'Amoja, Department of Highways and Transportation, Politecnico di Bari
Achille Fonzone, Department of Highways and Transportation, Politecnico di Bari

Synopsis

The awareness of the negative effects of transport asks research some urgent questions about the conditions for a sustainable mobility. The answer to these questions is needed to plan and to carry out organizational and structural interventions on transport systems able to bring about a real improvement of life quality and then to actually contribute to development. The intrinsic complexity of the matter is made worse by globalization that widens the geographic and temporal boundaries of problems.

An effective compass to find the way in this intricate context seems to be the knowledge of the native human needs whose fulfilment is the minimal goal for every development policy. Recent studies seem to corroborate the idea, persistent in some secondary lines of research and confirmed by the common experience but neglected by the current scientific paradigm, that an intrinsic positive utility is associated to mobility or, in different words, that the demand for mobility has a non-derived component. According to these studies, mobility phenomenon would be governed by an unobserved Time Travel Budget, linked to such a positive utility. If the existence of this latent desired Travel Time Budget were confirmed, its introduction in planning models could permit a better effectiveness of sustainable mobility policies.
The report presents a pilot study, preliminary to a regional-level research on the latent desire for mobility. The study has involved a sample of 100 people who have filled in a questionnaire with 88 questions about several dimensions of the matter of mobility. The collected data have been analysed with multivariate analysis techniques based on the procedures of multidimensional scaling proposed by the Data Theory Scaling System Group, Leiden University.
The analysis provides a confirmation of the existence of the unobserved desired TTB, an initial rough estimate of which is 1 hour per day, and it shows up the usefulness of introducing factors linked to the non-derived dimension of transport demand in the models interpreting mobility phenomenon.

#183 Proposal of a criterion for defining the levels of service in a quantitative way: the "service index"
Prof. Ing. Pasquale Colonna, PolytechnicTH University of Bari (Italy), Department of Highways and Transportation
Ing. Nicola Berloco, PolytechnicTH University of Bari (Italy), Department of Highways and Transportation
Synopsis
In this study a criterion able to define the traffic levels of service, not only qualitatively but also quantitatively, is proposed. Since 1950 (year of the Highway Capacity Manual first published edition) the traffic conditions have been synthetized in six levels of service that, when only considering some of the traffic influencing factors, turn out fundamental for the representation of a much more complex phenomenon.
The necessity of a quantitative representation of LOS remains undoubted in many models, where a numerical index would be more applicable; on the other hand, a numerical continuity of the same index would be more representative of reality, that changes punctually and not in discrete way. The search of an index that represents the road traffic levels and that varies from 0 (worst condition) to 1 (best condition) can be lead in several levels of complexities, described in the paper and improved and tested in future research.
The objective of the study is therefore the search of a function that allows to quantify the levels of service and to give them a continuous representation. It is chosen to be named "service index" the index variable from 0 to 1 representative of this function.

#184 Effectiveness of variable feedback signs for speeds on secondary rural roads in the area of Bari (Italy)
Pasquale Colonna, Polytechnic of Bari (Italy)
Vittorio Ranieri, Polytechnic of Bari (Italy)
Synopsis
The paper reports some experimental studies on the impact of variable feedback signs for speeds on drivers' behaviour. For this aim spot speeds have been collected on a two lane rural roads of the hinterland of Bari appropriately chosen according to its geometric and environmental characteristics. Data were collected using both a hidden radar speed detector and a radar reporting actual speeds on a panel clearly visible by drivers. The study allowed to draw interesting conclusion about the effectiveness of these signs.

#186 Drainage Issues Related to Porous Pavements
Vittorio Ranieri, Polytechnic of Bari
Synopsis
The paper deals with the issue of the drainage of porous pavements.

This kind of pavements can be divided into two main categories: full depth porous pavements and pavements in which only the friction course is porous. The first is widely used in parking lots and in urban areas where no heavy traffic is expected. For all other purposes, porous friction courses are used: 3 ÷ 5 cm thick in the European practice, about 2 cm in the US practice. The paper focuses drainage issues related to these porous friction courses.
After a brief description of the main features adopted to solve this problem, a model is presented in order to predict the need of sub-drains and their spacing.
This model is the evolution of a previous one, in which some corrections have been introduced taking into account some empirical findings. Originally the model was solved in order to find the maximum level of the water table flowing within the porous friction course. After the introduction of the empirical correction, the model has been further managed in order to find the maximum flow path length before the water starts flowing over the pavement. Thus, it has been solved again using the Runge-Kutta method and several runs have been performed simulating various scenarios of porous friction courses exposed to rainfall. The results of these simulations are reported in tables that provide the maximum flow path length that should not be exceeded to avoid the surface runoff.
These tables can be useful for practitioners to correctly design drain spacing.
For a given road section, the designer simply have to verify that the designed drain spacing does not exceed the maximum flow path length provided by the tables.

#188 The Development in the use of Porous Asphalts in Europe
Vittorio Ranieri, Polytechnic University of Bari
Synopsis
Since their first applications, porous asphalts soon showed their great potential as concerns safety and environment issues.
Thanks to their water drainage ability, in wet conditions they perform better than traditional hot mix asphalts as regards safety and comfort. Moreover, the high porosity gives them excellent acoustical properties. These factors determined their great success, especially in Europe, and justified the great efforts of research in order to give a solution to the problems arisen in the early applications.
In these pages, at first a general short description of the advantages/disadvantages and the history of these asphalts is presented. Afterwards, the main issues related to the durability and effectiveness of these pavements is given as arose since 20 years of use. Various solutions are given based on the European experiences. Finally, the main actual research lines to optimise and to improve the reliability of porous asphalts are outlined.

#191 Nigeria's Transport Infrastructural Development: An Integral Part of National Economic Empowerment and Development Strategy (Needs)
S.I. Oni, University of Lagos, Lagos Nigeria
Synopsis
Transportation infrastructural development remains a major tool for achieving the aspirations of the newly introduced economic principles of the Federal Government of Nigeria National Economic Empowerment and Development Strategy (NEEDS). Hence, the paper aims at empowering Nigerian basic livelihood through appropriate transport infrastructure investment. The production and their distribution costs through such investment will be reduced. Thus, higher level of production and consumption is achievable.
This paper also examines the past budgetary allocation strategies vis-à-vis the thoughts and the applicable parameters for the different transport sub-sectors. The paper further examines the structure of transport infrastructure development in Nigeria and suggests strategic reformation in the provision and financing of transport infrastructure. The paradigm shift leans more to stronger private sector participation. This alternative funding constitutes a way of minimizing the inefficiencies of public administration and avoidance of external borrowing.
This paper finally draws out the implications of the current discourse and experience for policymakers to place appropriate and adequate investment on transport infrastructure towards building strong, sound and viable economic environment.

#194 Privatised transit in combination with road-based congestion charging: An inter-modal equilibrium model

Muanmas Wichiensin, Michael G H BellTP1PT and Hai YangTP2PT

Synopsis

An inter-modal equilibrium model links an urban road network subject to a congestion charge to a parallel urban transit market, with a view to finding the optimum congestion charge consistent with the commercial decisions of the transit operator(s). The objective is the sum of consumer and producer surplus, which is maximised with respect to the congestion charge. Monopoly and monopolistic transit markets are considered. The prices and supply of transit services are treated as endogenous variables. The problem has been formulated as a bi-level programme. We demonstrate the results of the model using a small example giving insights into the problem.

Keywords: Congestion charge, Equilibrium model, Transit market