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Issue Highlights

ICAP Québec 2006

Sponsored by the International Society for Asphalt Pavements (ISAP), the 10th International Conference on Asphalt Pavement was held August 12-17, 2006 in Québec City, Canada. Over 600 people from around the world attended ICAP, which included a pre-conference program with courses and workshops, a technical program with over 180 paper presentations and an separate exhibition of consultants, manufacturers, suppliers, technical associations, and government agencies in the field of asphalt pavements. Dr. Yetkin Yildirim represented the Texas Pavement Preservation Center at ICAP 2006, presenting a paper entitled "Pavement Preservation Training." Enclosed in this newsletter are highlights of ICAP papers that focus specifically on pavement preservation.

Mark Your Calendar:
2006 Pavement Preservation Seminar

The Pavement Preservation Seminar will be held October 2-3, 2006 at the Austin Convention Center in Austin, Texas in conjunction with the 23rd Annual Association of General Contractors of Texas Trade & Equipment Show. Sponsors for the Seminar are the Asphalt Emulsion Manufacturers Association (AEMA), Associated General Contractors of Texas (AGC), Foundation for Pavement Preservation (FP^2), Texas Pavement Preservation Center (TPPC), and UT Center for Lifelong Engineering Education. Online registration begins September 2006. Please visit www.utexas.edu/research/tppc for more details.

ICAP Québec 2006
Selected Pavement Preservation Papers

Advances in Hot In-Place Recycling Technology by John Emery

Hot in-place recycling (HIR) of functionally deteriorated but still structurally sound asphalt pavements is a cost-competitive alternative process of potentially equivalent quality and performance with less road-user disruption, compared to hot-mix asphalt (HMA) overlay and milling/ HMA filling processes. The Martec AR2000 third generation HIR process is based on recirculating forced hot-air with low-level radiant heating, processing (hot milling), post heating, drying, mixing, paving, and a compaction system. This AR2000 third generation HIR system effectively deals with the recycling depth, heater efficiency and effectiveness, speed and productivity, emissions, and processing uniformity problems associated with previous second generation HIR systems. Preheaters heat and soften deteriorated old asphalt concrete using a combined hot-air/ low-level radiant heating system. Air in the combustion chamber is heated to about 600˚C and blown on the pavement through holes in the manifold, with the spent hot air recuperated and reheated. The softened old asphalt concrete is not damaged, and emission levels are very low. The preheater/ hot miller applies additional heat to enable the hot milling heads to loosen and remove softened asphalt pavement without degrading old asphalt mix. This unit has automatic depth control, and the hot milling heads can be adjusted to widths of 3.2-4.0 meters. The postheater/ dryer-mixer uniformly heats and dries while thoroughly mixing old, loosened asphalt mix with added new, corrective aggregate or HMA. The old, recycled asphalt mix is transferred to a pugmill for final mixing. The fully mixed renewed HMA is then transferred to a conventional paver for laydown, followed by compaction. When recycling to a depth of 50 mm, the AR2000 work speed may vary from 2-6 m/min, with an average production rate up to 10,000 m^2 of HIR typically completed per 10 hour working shift. Monitoring of AR2000 HIR projects, particularly Ontario Highway 401, has shown good performance, better than second generation HIR, micro-surfacing and milling/ filling with new or recycled HMA. The AR2000 third generation HIR process has demonstrated the ability to consistently and cost effectively renew and enhance premium asphalt surface course mixes. With the use of more long-life asphalt pavements and the recognition of top-down cracking surface distress, HIR should have an increasing role in asphalt pavement renewal. This will also involve associated asphalt technology advances such as Superpave, polymer modification, rejuvenator characterization and selection, and performance evaluation of the mix, in an overall systems approach to optimized HIR.

Analysis of Road Maintenance Sequences According to the Evolution of Distresses by F. Brillet, T. Lorino, and T. Dumeix

Within the framework of preventive maintenance policy by the French national network, pavements are subject to systematic distress monitoring programs and condition indicator measurements: sideways force coefficient, transverse unevenness and macrotexture. This methodology was established in 1992 as the “Quality Image of the National Roads” (IQRN) and includes a triennial survey of different distresses with a calculation of the total index. The analysis of such data made it possible to define laws of evolution for distresses, depending on initial structures, traffic and successive maintenance operations. In order to complement this approach, a joint analysis of the pavement evolutions and maintenance sequences was undertaken. Presented are statistical analyses of the relation between the evolution of observed distresses and maintenance decisions. Also presented is the pavement lifespan prior to overlay, according to observed deterioration, and the chosen maintenance technique to combat deterioration. The selection considers asphalt pavements excluding cement stabilized bases. The study shows that there are implicit rules, more or less marked, concerning the priority given to maintenance and the choice of the technique used (surface dressings, thin or thick asphalt overlays), according to the encountered problems (skid resistance, plastic deformation, fatigue or thermal cracking). The French road network comprises about a million km. of roadways. Thermal cracking and skid resistance are generally the pathologies that trigger maintenance. Of course, fatigue problems deserve more investigation. In order of magnitude, fatigue, which accounts for 20.7% of all pathologies on French roadways, corresponds to structural works (19.4%), while bearing capacity and plastic deformation (10.8%) correspond to heavy structural works (9.3%). All this reveals that, overall, the national network pavement structures were correctly designed, either at construction or after strengthening. The wearing courses found on French roads are primarily asphalt concretes (AC) and surface dressings (SD). The formula of ACs depends on their thickness, which is declined from "ultra-thin" to "semi-coarse”. Two questions were asked: “Which are the pathologies appearing on a given type of surface?” and “Which type of maintenance does a given pathology trigger?” In answer to the first question, there did not appear to be a clear relation: the surfacing does not seem to influence the observed pathology. Differences are related more to traffic level. Only some simple analyses were presented here, with, as principal conclusions, an evaluation of the past policies and practices followed by the decision makers. We could see, as well, that the roads with strong traffic had resistant pavement structures, which explain the prevalence of the maintenance works answering surface pathologies (skid resistance or thermal cracking), whereas the roads with low traffic, of which the pavement structures are often old and some never really strengthened, would more often require heavy works, which are not carried out in all cases.

APT as a Tool for the Development of Design and Performance Models by A. A. A. Molenaar

Molenaar summarized the work conducted at Delft University in close cooperation with the Dutch Ministry of Transport in the field of Accelerated Pavement Testing (APT). In the Netherlands, the APT device LINTRACK has been used for: verification of thickness design and pavement evaluation methods, development of visual condition performance models, permanent deformation behavior of several asphalt concrete mixtures and structures, calibration of design models for wearing courses on orthotropic steel bridge decks and response and performance studies on innovative pavement structures. APT has been used to determine to what extent linear elasticity can be used to predict strains and displacements in asphalt pavements. It has also tested if a mechanistic pavement design method based on linear elasticity could provide an accurate and acceptable estimate on the structural lifetime of asphalt pavements. During performance tests, regular measurements were made of the longitudinal and transversal strains at the bottom of the asphalt layer due to the test load, and also regular measurements were made of the permanent deformation and extent of cracking. Furthermore, FWD measurements were regularly performed. In conclusion, linear elasticity can be used and acceptable accurate pavement life predictions can be made provided that ample attention is placed on the characterization of traffic and climatic influences as well as material characterization.

Asphalt Pavement Rehabilitation: Using Sustainability in Decision-Making by M. Maher, K. Clarke-Whistler, and L. Uzarowski

Road networks, whether they are in the developed world or in the developing world, are a cornerstone of economic development. As the world population continues to increase and the earth's ability to sustain this growth is decreasing, the principles of sustainability must be incorporated into all aspects of the planning, design, construction, rehabilitation and maintenance of road networks. The impact of development on world ecosystems is a function of growth in population, increasing affluence (such as measured by income per capita) and technology (as measured by emissions per unit of production). Population growth and increasing affluence are realities; thus, the levers available to us to help slow the continual depletion of limited resources must focus on improvements in technology. Over the past 25 years, applied pavement research has given pavement design engineers tools to incorporate greater innovation into pavement rehabilitation schemes. One resource management tool that can assist highway agencies, planners, contractors and design engineers in identifying mechanisms whereby social, financial and environmental issues can be integrated into the management and planning of road rehabilitation works is a simple rational process for incorporating the principles of sustainability in a meaningful way into selecting the optimum road rehabilitation design. Any system that assesses contributions to sustainability must consider economic, environmental and social impacts. The economic and environmental aspects can be relatively easily quantified, but social opportunities are generally less tangible and so more difficult to integrate in a practicable tool. To allow some quantification of the sustainability of a particular pavement rehabilitation option, a simple selection tool has been developed based on an approach put forward for the management of construction and demolition waste in land development projects. In this suggested sustainability selection process, a series of indicators are applied to the specific road project. The output is in the form of a total score for each performance indicator comparing the viable rehabilitation alternatives. This then allows the stakeholder acceptability of each sustainable criterion to be compared, and the use of weighting factors allows each alternative to be scored from a sustainability perspective.

Automated Paving with Data from Road Surface Profiling by P. Ekdahl, B. Nielsen, and B. Sävinger

The result from pavement maintenance often displays a difference between what is planned and the actual result on the road. Differences occur regarding asphalt volume or thickness, cross fall, and longitudinal evenness. The final result is mainly dependent on three factors: existing road surface profile, chosen maintenance technique (often asphalt thickness), and the actual work performance. In order to reduce these differences, a new methodology of how to perform and implement geometrical overlay designs has been developed. The methodology involves a geometric overlay design based on road surface profiling over the whole road width with Laser RST for an optimal balance between fill and mill volumes. The design is transferred to a digital guidance file for the paving machine. The innovation consists of a description of suitable combinations of hard- and software and a methodology for how to perform the paving works and a modified method to analyze the measured longitudinal profile. Furthermore, the system works with a relative length measurement, without any other local reference systems. This enables a simple and cost effective positioning system. The whole procedure has been tested on several projects. It has been especially actualized in connection to the current traffic safety program in Sweden, where many roads are re-designed to a 2+1 lane solution with rails separating the traffic. Those designs often require a transfer of the height ridge, a road widening and a corresponding change in geometry. The procedure has been awarded a prize for "Innovation of the year 2004" by the Development Fund of the Swedish Construction Industry.

Chip Sealing Systems: Improving Early Age Chip Retention by Anton Kucharek, Keith Davidson, and Jean-Martin Croteau

A number of solutions aiming at better chip retention have been tried over the years, such as using quick-set polymer-modified emulsions, using smaller and cleaner chips or modifying certain aspects of construction practices. This paper is intended to take an in-depth and

more systematic look at various technical aspects that can have an impact on improving early chip retention by an asphalt emulsion. A group of asphalt emulsions were selected for this laboratory study, containing both anionic and cationic types and having different types of polymer modifications. Curing of the emulsions was studied by assessing the development of film strength in the binder layer by rheological measurements and by the Frosted Marble Cohesion test. Subsequently, chip retention on a variety of stone types was assessed by means of the Sweep Test for Surface Treatments. Ten asphalt emulsions were analyzed with respect to their curing properties during the first 24 hours. Each emulsion was subsequently tested with three different aggregates for assessing stone retention using the sweep test. The cationic emulsions studied developed cohesion and modulus quicker than the anionic emulsions under similar curing conditions. The distillation residues showed comparable modulus values, but the time needed for the curing emulsions to achieve that modulus range was significantly shorter for the cationics. Measuring the cohesion of the curing emulsion by the Frosted Marble test reflected the same trend. The type of polymer modification of the emulsion impacts the film strength development in the very early stages of curing. PMA emulsions can benefit of their polymer content within the first 2 hours while emulsions containing latex require more curing time before the polymer becomes of benefit. Within 24 hours under the described curing conditions, their performance becomes comparable. This behavior has been more obvious with cationic emulsions. Anionic emulsions containing PMA and latex have shown fairly similar behavior. Combination PMA-Latex emulsions have performed well, but no special benefit has been observed so far from having the SBR polymer both inside and around the asphalt binder. More research is needed to fully characterize such systems. The strain tolerance of the emulsion residues increases with curing. As they cured faster, the cationic emulsions in our study have shown less strain dependency during early stages. This should be beneficial for improved early stone retention, as failure in fresh chip seals is predominantly cohesive in nature. The study allowed no direct comparison between distillation residues and cured emulsions, as during the first 24 hours at room temperature complete curing of the emulsions is not achieved. However, the properties of distillation residues seemed to poorly reflect the properties of cured cationic latex modified emulsion residues in particular, confirming earlier literature observations. The cationic emulsions have performed consistently better in sweep tests with all the aggregate studied. They have also shown less sensitivity towards the different chemical composition of the stone than the anionic emulsions. The results of research underlined the many factors that affect early stone retention following the construction of a chip seal. It emphasized the need for the engineer to thoroughly assess all the aspects affecting the final chip seal design. Good material evaluation, selection and understanding beyond basic specifications are critical of achieving best possible results.

Compaction of HMA with a Vibratory Pneumatic Tire Roller by Y. Nose Y. and J. Scherocman

A new method to compact Hot Mix Asphalt (HMA) pavement was recently developed in Japan. This system consisted of a relatively small, seven tire pneumatic tire roller that can be operated in the vibratory mode–a vibratory pneumatic tire (VPT) roller. It was previously found that the VPT roller could achieve the required level of density in a HMA mix using fewer roller passes and that the roller achieved a more uniform degree of density throughout the thickness of the HMA pavement layer. In 2005, three additional test sections were constructed to further evaluate the capabilities of the VPT roller. The first project was at the Bakersfield Airport in California, where the density achieved with the VPT roller was compared with the density obtained with a static pneumatic tire roller that weighed more than twice as much. The second trial was conducted in Georgia, where various roller combinations were tested. It was determined that both the mainline pavement density and the longitudinal joint density were easily achieved when the VPT was included in the roller train. The third project was located in Japan, where it was confirmed that the use of the VPT roller would provide for a uniform density distribution throughout the depth of the pavement layer. The combination of the kneading action of the pneumatic tires and the vibratory force applied through the pneumatic tires provides “the best of both worlds” regarding the compaction of HMA mixtures.

Design and Instrumentation Plan for a Long Life Pavement in Ontario by B. Lane, T. Kazmierowski, S. Chan, and Dr. J. Ponniah

One of the primary priorities for transportation agencies is the extension of pavement service life and the reduction of delays to the public. Perpetual pavements or long life pavements are one answer to these demands. These pavements increase the time between resurfacing, with a corresponding rise in structural value. A perpetual pavement is essentially a flexible pavement that is designed to resist structural failure, minimize cracking and rutting, and last for more than 50 years with only occasional maintenance. The Ministry of Transportation in Ontario, Canada (MTO) will begin construction of its first perpetual pavements this year in 2006, beginning with Hwy 406 and a reconstruction of Hwy 402. The reconstruction project will be conducted in three different sections: a 4 km section of perpetual pavement with a rich bottom mix as a lower binder; a 4 km section of perpetual pavement with Superpave 25 mm as the lower binder and a control section of conventional flexible pavement. Installed moisture probes, earth pressure cells and asphalt strain gauges will collect data from these sections to help understand how different pavement structures react and perform under various traffic and climatic conditions. Data results will greatly assist in assessing the field response of perpetual or long life pavement designs, particularly in regard to design criteria and methodology, failure mechanisms of the different pavements, how asphalt

material properties relate to long life behavior, the optimum maintenance strategy for perpetual pavements, how to calculate the life cycle costs and benefits, impact of material and construction and the adoption of perpetual pavement concepts.

Development of Hot In-Place Transforming of Dense Graded Asphalt Mixture to Porous Asphalt Concrete by H. Hosokawa, A. Gomi, T. Okuno, F. Goto, S. Tanaka, and A. Kasahara

A new technology has developed for hot in-place that is different than hot in-place recycling. Called Hot In-Place Transforming, the new technology transforms dense graded asphalt concrete to two layers of porous asphalt as the surface layer and mastic gap asphalt that supports the layer. The process consists of a train of 5 automated machines, 2 preheaters, a heater/miller, a separator and a mixer/tandem-paver followed by conventional rollers. The key to the new technology is the separator with a screening device that separates hot asphalt coated aggregates according to size. To produce even heating for efficient aggregate separation, hot air is used as an air mat rather than jet air, which is what hot in-place recycling machinery uses. The tandem paving technology paves through one pass for two layers of different-graded asphalt mixes. The new technology was tested successfully in 2005 on Route 77 in Okinawa, Japan, demonstrating that the operation ran at a speed of 2m/min and paved porous asphalt with a single pass. Water permeability and surface roughness requirements were satisfied. It is also notable that a large reduction in greenhouse gas emission, including that of carbon dioxide, was achieved through this new rehabilitation process as compared with the conventional mill/fill process.

Evaluation of Automated Distress Collection Techniques: An Ontario Case Study by R. Capuruco, S. Tighe, L. Ningyuan, and T. Kazmierowski

Pavement management systems (PMS) rely on consistent and repeatable distress data collection to perform efficiently. This data has been traditionally collected via manual surveys, which tend to be subjective and time consuming. The Ministry of Ontario (MTO) has initiated a study with the University of Waterloo to determine if certain systems may be suitable for collecting data at a high rate of speed and with state-of-the-art image capture equipment and ultimately, for replacing the traditional manual approach. MTO will be producing a set of recommendations and guidelines. In so doing, a data management plan for collecting consistent data was set in place, and a set of similar distresses were selected to serve as the response variables. An advanced analysis of variance was then conducted to permit statistical data comparisons among contractors and the automated technologies. Results indicate that there are not significant differences between contractors' measurements using the sensor-based equipment, but significant differences in measurement were observed with measurements taken using digital image-based technology. Improvements could be made in the quality of the image-capturing, providing more training to data analysts (process related problem), or enhancing/ proof-checking distress identification-oriented algorithm's routines (software related problem). Additionally, this might provide an opportunity for agencies to introduce new and/ or stronger standardization practices for image-based technique. Furthermore, in order to better assess the new technology's accuracy, it is necessary to compare its data results with that of manually-acquired data results.

Evaluation of Cold-in-Place Recycling Using Foamed Asphalt by A. Loizos, V. Papavasiliou, and C. Plati

Cold In-Place Recycling (CIPR) using foamed asphalt stabilization is a viable alternative for rehabilitating pavements in comparison to the increasingly expensive process of hot in-place recycling.

In light of the increasing cost of hot mixed asphalt mixtures and the limited availability of good materials, Cold In-Place Recycling (CIPR) using foamed asphalt stabilization offers an attractive alternative for rehabilitating pavements. Because of its limited performance history and the unavailability of a standard mix design procedure, the use of CIPR using foamed asphalt stabilization had been limited mainly to low to medium volume roads. The lack of experience, at least as far as the performance of the aforementioned technique for heavy duty pavements is concerned, was the reason for the Greek Ministry of Public works to undertake a field experiment on the purpose of the rehabilitation of a severely damaged heavy trafficked highway (part of the Trans European Network) that incorporated semi-rigid and flexible pavements. In order to achieve this goal, a comprehensive monitoring and data analysis research study was performed, concentrating on the Falling Weight Deflectometer (FWD) as a major tool for the in situ evaluation of the early life performance of the recycled pavement. In addition, roughness as well as Ground Penetrating Radar (GPR) measurements, accomplished with in situ material coring and related laboratory tests, were performed. The major findings of the research study are presented and discussed in the present work.

F. E. Study of Critical Cracking Condition in Asphalt Overlay by F. Moghadasnejad and S. Toolabi

It is readily observed that HMA overlays may prematurely display cracking patterns similar to those that were existent in the old, underlaying pavement. Such cracking is due to the inability of the overlay to withstand the shear and tensile stresses created by movements concentrated around preexisting cracks. Moghadasnejad and Toolai studied the main factors in the development of cracks in overlays using the finite element method. Factors that were investigated included crack width, overlay thickness, and load position. Evaluation criteria included tensile stresses, shear stresses, and the stress intensity factor. According to results, it was concluded that, by themselves, any of the single fracturing modes (opening

or shearing, for example) were not enough to calculate asphalt overlay fatigue in comparison to a combination of fracturing modes. It is shown that existence crack at the bottom of overlay causes increasing shearing stresses up to five times in comparison to overlay without any cracking. According to results, an increase in tensile and shear stresses near the crack tip are in some extent related to crack width.

Good News on Quality of Automatic Crack Collection by P. Offrell, Juha Äijö

Since the 1980's automatic road surface measurements of rutting and unevenness has been performed on the Finnish road network using automated level of service measurement vehicles. Crack data has been collected manually by visual inspection, and the Finnish Road Administration (Finnra) has an ambition to replace the crack inventory methodology with automatic crack measurements. This paper describes a test project conducted June 2004, where automatic crack data collection was made with two different types of crack measurement equipment, — PAVUE and Adhara system (previously known as "Samsung system ") — and visually. The scope was to investigate the benefits and drawbacks of automatic crack data collection and estimate which measures should be used to present the automatically collected crack data on network and project level. The conditions for the test were normal production type measurements and the length of the test sites were 100 km. The results show that both automatic crack data collection equipment could produce crack data with good quality. The repeatability varies with used equipment type. The sensitivity was influenced by the used illumination while collecting the crack data and the pavement type (Asphalt Concrete or Soft Asphalt). The test showed that existing automatic methods can replace manual surveys on road network level with both improved quality and more detailed information of, for example, the crack position, etc. Based on the results from the test project, the Finnish Road Administration has decided to start using automatic crack data collection from the year 2006.

Improvement of the Surface Characteristics Regarding the Safety and Comfort of the Users by Yves Brosseaud and Michele St-Jacques

The main concerns of the construction financing authorities and people in charge of road maintenance in industrialized countries concentrate on the improvement of safety of the users and on the comfort of road displacements, and also take into account bordering populations. A judicious choice of the structures (durability) and especially of the nature of the wearing course, makes it possible to offer a combination of better conditions of adherence while authorizing a significant reduction of the noise level and a better division of the space for the various road users. A database on the skid resistance performances (CARAT) allows the consolidation of the state of knowledge on the performance of pavement surfacing and contributes to developing and evaluating new products. The influence and the durability on skid resistance of a particular family, including the composition, grain size, nature of the binder and polishing strength of the aggregate, is examined. Use of a highly skid-resistant surfacing on more hazardous sites, coupled with application of the micro-encrustation technique designed to enhance early-age skid resistance, is also detailed herein. Current trends with respect to road maintenance and surfacing choices are indicated. The article closes with a look at the prospects for new techniques to enable increasing the durability of surface characteristics and thus spacing the schedule of maintenance interventions.

Innovative Surfacings: What's New in New Zealand? by Bryan Pidwerbesky and David Faulkner

Jawad and Ozbay stated that optimizing the life-cycle cost of transportation infrastructure is a strategic approach for achieving sustainability of infrastructure systems. They present a life-cycle cost optimization model (LCCOM), developed for analysis at the project-level for pavement management. In order to identify a life-cycle strategy that can bring about an optimum gain to society, the life-cycle cost optimization must look at every feasible life-cycle strategy and consider every possible impact that may be caused by placing the system into operation. The research presented creates the opportunity for further exploration of project-level probabilistic cost optimization in real-world decision making. The main goal of life-cycle cost optimization is to ensure that infrastructure facilities are managed (planned, constructed, operated, maintained, and rehabilitated) in a manner that brings about the best gains for present and future generations. Life-cycle cost optimization is a broad concept that can be applied at different levels of evaluation and to different categories of infrastructure systems. A thorough research in this area has resulted in noticeable advancement as it is steadily being integrated into practice and the decision making process.

Modeling Long-Term Flexible Pavement Performance of Ontario Highways by N. Li, T. Kazmierowski, and B. Lane

The Ministry of Transportation of Ontario (MTO) uses several multiple performance indices in the newly implemented MTO Second Generation Pavement Management System (PMS/2). These indices can be used jointly or individually to assess pavement performance in terms of overall Pavement Condition Index (PCI), ride comfort index (RCI), International Roughness Index (IRI), and Distress Manifestation Index (DMI). Each of the evaluation indices may be used to address current pavement serviceability and predict future trends in functional adequacy, such as pavement structural strength and distresses. This study presents the long-term flexible pavement performance observed in the field after reconstruction or rehabilitation, as represented by a number of pavement maintenance and rehabilitation (M&R) strategies that are commonly used for preservation of the Ontario highway network. Historical construction records and provincial contract documents indicate that all of the

1,732 pavement sections in the provincial network have experienced at least one if not several significant rehabilitation activities since 1985. The long-term pavement performance trends of these pavement sections have been reported annually by PCI, RCI and DMI for the past twenty years. The paper concludes with discussions and recommendations to modify the existing pavement performance prediction models that are currently used in the PMS/2 through correlation with the actually observed pavement performance trends for each type of pavement rehabilitation/reconstruction treatment.

Optimization of Joint and Crack Sealant Selection Criteria Based on Laboratory and Field Performance by T. Worms, A. Shalaby, and L. Kavanagh

The optimized selection of joint sealants can extend pavement service life and reduce annual maintenance and rehabilitation needs, particularly in regions, which experience extreme climatic conditions. Early sealant materials were not subjected to standardized testing procedures, and many failed as a result. Since then, several empirical test procedures have been proposed, and a few have been adopted into approved standards by bodies such as the American Society for Testing and Materials (ASTM). Variability within the sealants, their application methods, and the empirical nature of the test methods made it difficult to predict sealant behavior in the field. The purpose of this research was to develop a performance-based laboratory testing approach, and to investigate and rank the performance of eight types of hot-pour joint and crack sealants for applicability of use in Manitoba. The research is a joint effort between the Manitoba Department of Transportation and the University of Manitoba. The project involved laboratory testing of sealants to verify fundamental properties and performance simulation under cyclic loading at three test temperatures: +30ºC, 0ºC and -30ºC. The results of the laboratory tests indicated that ASTM Type I (high modulus) sealants exhibited higher initial resistance to loading and also experienced adhesion failure at both the 0ºC and -30ºC test temperatures. The ASTM Type IV (low modulus) sealants generally exhibited lower resistance to load, and three of the eight sealants did not show signs of failure at any of the three test temperatures. In an effort to optimize the sealant selection criteria, the laboratory performance is compared with field performance in a controlled field trial. The trial involved evaluation of the failure rates of sealants on an asphalt pavement section on the TransCanada highway, which is the primary highway that connects Canadian provinces.

Overlay Tester: A Simple and Rapid Screening Test for Characterizing Crack Resistance of HMA Mixes by Fujie Zhou and Tom Scullion

Stiffer binders and good stone-to-stone contact may provide improved rut resistance, but they may also reduce the mix flexibility and thus, crack resistance. Today this cracking phenomenon is getting more attentions from pavement engineers. Cracks appear in flexible pavements primarily through fatigue, low-temperature, or reflective cracking mechanisms. This paper investigates the feasibility of using the Overlay Tester (OT) as a simple test for characterizing crack resistance of asphalt mixes. The OT can be run on standard size samples, typically 150 mm long by 75 mm wide by 38 mm high, which can be prepared from either field cores or from lab molded specimens. Sensitivity studies indicated that the OT provides reasonable results, in that raising the asphalt performance grade and decreasing the testing temperature will lead to shorter cracking life. Furthermore, in a series of controlled tests it was found that asphalt absorption by aggregate appears to have a major impact on crack resistance of asphalt mixes. The effectiveness of the OT as a crack resistance test was validated by five reflective cracking case studies in Texas and test conducted on cores from MnROAD low-temperature cracking sections. The OT results correlated well with field performance. A laboratory study was also conducted to compare the OT results with those from the bending beam fatigue tests. A good correlation was also obtained. In summary, the OT device appears to be a practical tool to characterize cracking resistance of asphalt mixes and to let the mix designer balance the competing requirements of both rut and crack resistance.

Pavement Preventive Maintenance Concepts and Techniques by D. Hein and J. M. Croteau

Many pavement owner/agencies are now focusing on maintaining the overall value of their roadway assets and are striving to make better-informed decisions on how they allocate funding to minimize the deterioration of their assets. This new form of management, referred to as Asset Management, has clearly identified the benefits of strong pavement preventive maintenance programs compared to the commonly used “worst-first” repair approach. A strong pavement preventive maintenance program offers an opportunity to help close the gap between pavement maintenance needs and optimal pavement condition to better serve the traveling public. An effective pavement preventive maintenance program encompasses a full range of techniques with the goal of enhancing pavement performance in a cost-effective and efficient manner. A framework of mix-of-fix strategies, which includes a balance between pavement preventive maintenance work along with pavement rehabilitation and reconstruction, can assist a road agency to maintain an overall acceptable pavement condition, while meeting the needs of the traveling public. This concept, as simple as it seems, has not been fully accepted by roadway agencies, who continue to react to problems after they occur rather than preventing them from occurring in the first place. This paper describes the concepts of pavement preservation and outlines several typically pavement preservation techniques.

Practical Aspects of Maintaining a Busy Old Motorway, While Keeping Traffic Moving by P. L. Scott and K. van Donderen

The M4 motorway, close to London Heathrow Airport, Windsor and Slough, needed maintenance. This major maintenance scheme, which cost £13million; involved a three-lane dual carriageway 4 kilometers long. No major work had been carried out on it since 1970, and it carries 160,000 vehicles per day into and out of London, with the main flows between 6am and 10.00pm. There were substandard features that included discontinuous hard shoulders, which meant that hard shoulders could not be used for traffic management to keep traffic flowing. Little or no work could be carried out during the day without causing enormous congestion as it is very close to the M25, the main London orbital motorway. The road runs through high-density residential areas, which made noisy nighttime working an issue. All this makes this road to be almost unmaintainable. A contract duration of 20 weeks was set as the maximum that road users, businesses and residents could tolerate. As a consequence, the design was changed and re-scoped to achieve a pavement design life of some 10 years before the next major maintenance whilst keeping the traffic moving in the meantime. This included a very large free vehicle recovery operation. A comprehensive communications strategy was also developed for the scheme, which commenced nine months in advance of works starting on site. This communication strategy and plan made a significant contribution to the whole scheme being a success. Traffic delays were almost held to the norm. This paper discusses how the works were tailored to suit the constraints, the comprehensive approach to informing the Road Users, Stakeholders, Press and residents, and how current practices within the Highways Agency have changed.

Recent Development in Recycling Binders for In-Place Cold Recycling of Bituminous Aggregate by J. M. Croteau and K. Davidson

Many millions of square metres of roadway have been rehabilitated using the in-place cold recycling process in Canada. The driving engine of in-place cold recycling is associated with the concept that existing pavements are sources of primary roadway materials. The existing pavement is reclaimed and transformed into a bituminous aggregate, treated with a recycling system and placed and compacted in-place. The nature of recycled mixtures differs significantly from hot mixtures. Hot mixtures are usually two-part systems, whereas, recycled mixes are multi-part systems, including: aggregate, aged binder, recycling binder and possibly corrective aggregate and other additives. Additionally, water is added during recycling for coating and compaction. The air voids content of recycled mixtures is much greater than hot mixes. A small amount of recycling binder is added to bituminous aggregate; consequently, the build up of cohesion of recycled mixtures is highly dependent on the nature of recycling binder, the properties of aged binder, the addition of corrective aggregate and additives, if required, the curing conditions and the mixture densification. The selection of recycling system is based on the characteristics of bituminous aggregate, the expected interaction of recycling binder with aged bitumen and the site constrains/conditions. The paper proposes a classification of recycling techniques based on objectives, materials and recycling systems. It defines the performance of recycled work in accordance with material mechanistic properties and field constructability. It provides information on the parameters used to engineer recycled mixtures. Finally, it describes the field conditions that influence the performance of recycling material.

Return on Investment Analysis for Long Life Asphalt Pavements by R. Haas, S. Tighe, and L. Cowe Falls

It is becoming increasingly necessary in life cycle analysis (LCA) of infrastructure assets, including pavements, to take a longer term approach than in past, conventional practice. This is largely for reasons of ensuring sustainability and assessing the future impacts of today's decisions. Life cycle analysis can be primarily in terms of life cycle cost analysis (LCCA) but can also include considerations of resource conservation, environmental impacts, energy balance, etc. A reasonable time horizon for life cycle analysis should involve short, medium and long term periods, in the order of 25, 50 and 100 years, respectively. Conventional LCCA compares competing alternative investment strategies and can involve a range of stakeholders, from the elected level to the public at large to suppliers and consultants. Of the methods available, present worth of costs is almost exclusively used in the pavement field. However, when medium to longer term life cycle periods are involved, rate-of-return and cost-effectiveness formulations can be applicable and should be considered. A numerical example is provided which shows how an agency can determine the internal rate of return (IRR) for an investment alternative involving a long life different pavement design and a life cycle period of 50 years. Conventional LCCA for calculating present worth of costs will undoubtedly continue to be used in the pavement field as a primary tool. However, going beyond conventional LCCA and using a rate-of-return or cost-effectiveness formulation, especially for medium to longer term life cycle periods, should be given more consideration.

Surface Treatments in Asphalt Pavements: A Systems View by S. Senadheera

Fu et al. attempted to quantify the effects of winter weather and maintenance treatments on the safety of highways. This research is integral for a cost-benefit analysis of alternative maintenance strategies and methods as well as effective communication of the impacts of these strategies and methods to the decision makers and public. Statistical analysis was performed on data collected from two highway routes in Ontario, Canada. The obtained data included daily accident occurrences, weather conditions, and winter maintenance operations. Researchers attempted to answer many questions in this comprehensive study, including 'How much improvement can be expected from technology-enhanced maintenance systems and operations?' The extent to which maintenance operations should be applied and the effects of application conditions were also studied. Anti-icing

operations were confirmed to be more effective than the combined operations of plowing and pre-wet salting. Variation within these operations may be small despite the differences in weather conditions; therefore, crash frequency, as the object of study, becomes less quantifiable. Also, there is significant variation in local snow conditions due to drifting and shading, resulting in a large variation of snow cover and, therefore, safety. The project initiated the task of quantifying impacts of winter weather and maintenance operation on safety, but it has only focused on its effects on crash frequency. Future research should examine the impact of these factors on crash consequences. Past studies have found that the consequences of a crash are usually lower in winter seasons due to reduced travel speeds, but the effects of maintenance operations on crash frequency has yet to be quantified.

Considerations for Establishing a Pavement Preservation Program by Teresa M. Adams and Myungook Kang

Adams and Kang established that a pavement preservation program cannot work effectively without a programmatic framework. Such an organization enables optimization and defensible pavement preservation decisions by providing the information needed to analyze and justify budget trade-off decisions. Adams and Kang discussed the essential characteristics of a pavement preservation program, obtained from the analysis of eight state transportation departments. The study noted that each dollar spent now on preventive maintenance saves up to six dollars in the future, and case studies show that pavement preservation programs can be established with relatively low investments and can lead to significant cost savings. Though agencies have been implementing pavement preservation techniques for a long time, agencies must create an organized program to realize the full benefits of such strategies. Ten features of a successful program were identified. For one, the motivation for establishing the program should be clear. Such motivations may include savings through pavement life extension, improved ride quality and fewer rehabilitation projects. Also, preservation projects and strategies must be selected using consistent guidelines and databases. Agencies must also develop procedures for anticipating maintenance needs and provide a dedicated budget with federal support. Employees should be educated on benefits and concepts of pavement preservation, and ongoing program evaluations directly impact continued improvement and performance.

Degradation of Bituminous Sealants Due to Extended Heating before Installation: A Case Study by J-F. Masson, Peter Collins, Sladana Bundalo-Pere, John R. Woods, and Imad L. al-Qadi

Masson et al. tested bituminous sealants that are applied to cracks and joints in pavements, bridges, and other civil engineering structures. The objective of their testing was to better understand the effects of installation on sealant properties. Crack sealing treatments are generally applied at 180°C, a temperature at which the sealant can degrade. By measuring the molecular size, type of bond (sealant to crack wall), and the temperature at which the sealing material becomes ash and gas, they found that the material was most degraded early in the morning as a result of long pre-installation heating times at 150°C. This non-oxidative degradation led to sealant stiffening, a result of changes in polymer structure and loss of bitumen and polymer contents. This loss of organic material resulted in an increase in filler content. Control of sealant preparation conditions prior to installation is crucial for optimized sealant performance. This control includes the time and temperature of the sealing material prior to and during installation.

Infrastructure Asset Management Education: Active Learning and Engagement-Based Practices by Omar Smadi and Akili Waddah

Several transportation asset management courses are being taught as part of university curricula as the asset management of civil infrastructure facilities and systems becomes increasingly important. A few institutions have implemented well defined programs related to infrastructure asset management. Smadi and Waddah outlined a class offered at Iowa State University to civil engineering and transportation planning graduate students. Underlying the curriculum at Iowa State is the concept of 'active learning', broadly defined as any instructional method that engages students in the learning process. Cooperative and problem-based learning techniques are also used to enhance the role of group work and problem solving in engineering. Smadi and Waddah outlined the class syllabus, the active learning techniques utilized and a sample class project. As asset management system development becomes more important, more demand will be placed on academic institutions to provide proper training. Thus efforts need to be made to standardize the training process, and education in this area can operate to further improve an engineer's critical thinking and managerial skills.

Optimum Decision Making and Uncertainty Analysis at Programming Level of Pavement Management Systems by Ashim Shivakoti and Hamid R. Soleymani

Shivakoti and Soleymani based their study on the idea that decisions made at the programming level of Pavement Management Systems (PMS) have the highest economic impact and determine the effectiveness of decisions taken at the project selection and project levels. Pavement performance depends on many parameters, including construction quality, materials, environment, drainage, traffic, and the interaction of these parameters. Shivakoti and Soleymani presented a methodology to address the issue of optimum decision-making and uncertainty analysis. Goals of the proposed methodology included enabling the decision-maker to optimize budget allocation and providing the decision-maker with multiple optimal solutions in order to balance the

objective function and the impact of uncertainty on the optimal solution.

Upcoming Events

Pavement Preservation Seminar
October 3, 2006 – Austin, Texas

The Pavement Preservation Seminar, scheduled for October 3, 2006 in Austin, Texas, will present a thorough overview of the latest concepts, techniques, and materials related to pavement preservation. Seminar topics will include Asphalt Overlays, Scrub and Fog Seals, Crack Sealing Techniques and Materials, Chip Seal Best Practices, TxDOT Questions and Answers, Hot-in-Place Recycling, Micro-Surfacing and Slurry Seals, and Pavement Management Systems. In recognition of the need for education and training related to pavement preservation, AGC, AEMA, FP^2, and the Texas Pavement Preservation Center will collaborate in conducting the 2006 Pavement Preservation Seminar. The 2006 Seminar will be presented in conjunction with the 23rd Annual AGC of Texas Trade and Equipment Show.

For updates visit the Texas Pavement Preservation Center (TPPC) website: www.utexas.edu/research/tppc.

Our Mission

The mission of TPPC, in joint collaboration with the Center for Transportation Research (CTR) of the University of Texas at Austin and the Texas Transportation Institute (TTI) of Texas A&M University is to promote the use of pavement preservation strategies to provide the highest level of service to the traveling public at the lowest cost.

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