Pavement Preservation Saves Lives
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Introduction - In the background for current SAFETEA-LU legislation, it is noted that poor pavement conditions (including inadequate texture/friction) contribute (not cause) up to 30 percent of the annual fatalities. However, in a recent study, it has been reported that in 2006, roadway condition was a contributing factor in 31.4 percent of the total crashes, 52.7 percent of the 42,642 fatalities, and 38 percent of the 5,746,231 non-fatal crashes. These motor vehicle crashes cost the U. S. economy more than $217 billion each year. This is 3 ½ times the $59 billion government at all levels is investing annually in roadway capital improvements. The estimated cost by cost factor were: Seat Belt Non-Use - $59.6 billion; Speeding-Related - $97.1 billion; Alcohol-Related - $129.7 billion; and Road Condition-Related - $217.5 billion (Miller and Zaloshnja 2009).

Also, the AAA has found that when motorists talk about transportation problems, they usually key in on traffic and congestion. Yet the more costly problem to be addressed on American roads is motor vehicle crashes. Most Americans would be surprised to learn the societal costs associated with motor vehicle crashes significantly exceed the costs of congestion. The study, along with recommendations for improvements, is designed to raise awareness of the importance of transportation investments, and provide policy-makers, departments of transportation, and the public on the magnitude of the safety problem (AAA 2008). Key findings of the study include:

- In the urban areas studied, the cost of traffic crashes is nearly two and half times the cost of congestion - $164.2 billion for traffic crashes and $67.6 billion for congestion.
- The crash costs include property damage; lost earnings; lost household production (non-market activities occurring in the home); medical costs; emergency services; travel delay; vocational rehabilitation; workplace costs; administrative; legal; and pain and lost quality of life. The economy and the environment are impacted but those are not quantified in the study.
- Improving safety may improve congestion. Forty to 50 percent of all nonrecurring congestion is associated with traffic incidents.

Clearly, the economic effect of the unacceptable number of annual deaths and serious injuries needs to be considered in all phases of highway engineering and management.

New York's 1990-2000 Pavement Preservation and Safety Appurtenance Management Programs - In the 1990's, New York conducted extensive pavement preservation and safety appurtenance improvement programs. A summary of the program highlights includes:

- New York reduced annual deaths from 2217 in 1990 (2.07 fatalities per 100 MVMT which was the same as the national average) to 1460 in 2000 (1.13 fatalities per 100 MVMT compared to national average of 1.52 fatalities per 100 MVMT). This was a 34 percent reduction in the number of annual deaths in a 10

year period which is an outstanding accomplishment. The estimated annual savings are $2-3 billion per year.

- In 2007, New York had 1333 fatalities and a fatality rate of 1.02 per 100 MVMT. In 2008, they had 1231 fatalities (NHTSA 2009) or a 45.5 percent reduction in 18 years (1990-2008). Their excellent program continues to pay huge safety dividends.
- Percent of roads in poor condition was reduced from 10 percent to 5 percent and the percent of roads in good condition was increased over 20 percent. Improving the pavement surface condition using non-carbonate aggregates in HMA overlays or microsurfacing does reduce crashes and must be recognized as a cost-effective countermeasure.
- New York is also implementing the road safety audit concept within its pavement overlay program. Crash reductions have ranged from 20 to 40 percent depending on the type of improvement. Note that the total crash reduction is greater than what would be expected from reducing wet pavement crashes only.
- A recent TRB paper (Lyon and Persaud 2008) documented the cost effectiveness of the New York State Skid Accident Reduction Program (SKARP) approach. This has also been included as Appendix D of NCHRP Report 617,and is expected to be incorporated into the FHWA SafetyAnalyst program now being tested before widespread distribution (Ogle 2007) and into the Highway Safety Manual now being edited by AASHTO for publication in early 2010.
- This approach has also been recommended for Implementation in the 2008 Ohio Friction Study recently completed (Larson et al. 2008). As the Ohio DOT does not have an annual network wide friction survey, the emphasis is on:
    - monitoring the percentage of wet/total crashes and the number of wet pavement crashes on each site category/section of the highway network within three months of the end of the previous calendar year,
    - obtaining FN40R friction numbers and macrotexture (laser based) on the sites meeting proposed Intervention and Investigatory Level crash data criteria, and
    - taking action based on the criteria recommended (modified as needed due to small survey sample used during Implementation Plan development).

The process recommended in the Ohio Friction Study will also work when States do not conduct friction studies of the entire highway network every year. This process will identify sites/sections where more frequent monitoring or some early corrective action may be warranted or desirable.

Improving the pavement condition (which was estimated to contribute to, not cause, up to 52 percent of the annual highway fatalities in 2006) during pavement preservation is a proven cost-effective approach to reduce the current annual deaths and serious injuries. Research to better document the effectiveness of these actions is needed so that this critical skid resistance countermeasure is given more adequate consideration by highway engineering professionals. Only when this approach is widely implemented, will we start to see dramatic reductions in the annual number of deaths and serious injuries in the U.S.

Safety benefits of pavement preservation or preventive maintenance - Region of York, Ontario - One recent effort to evaluate preventive maintenance techniques implemented to improve pavement performance and safety was conducted in the Region of York, located north east of Toronto, Ontario, Canada. Often times these maintenance methods were selected because they seemed the most appropriate given budget constraints; however, little was known if these treatments impacted safety. The Region of York made their road and safety data accessible for the purpose of the research. The focus of the effort was to gain an understanding of how microsurfacing and resurfacing treatments impact road safety to help the Region of York and potentially other jurisdictions make more sound decisions when selecting pavement maintenance treatments (Erwin and Tighe 2008).

Given the high costs to society for crashes (including congestion delays as documented by AAA), it only seems logical that safety should be a major part of a preventive maintenance decision making process. A fair amount of research has been done on the influence of pavement friction on traffic safety; however no studies were uncovered that examined how microsurfacing (a treatment designed to improve the frictional properties of pavement) affected safety. This study accomplished five research objectives based on the needs of the Region of York and past experience:

1. Establishes that there is statistically significant relationship between microsurfacing treatments and safety for specific traffic conditions using a before-after analysis.
2. Determines that there is a statistically significant relationship between resurfacing and safety under specific traffic conditions using a before-after analysis.
3. Illustrates the need and value added if there is better cohesion between road data and safety data.
4. Demonstrate that safety has a role to play in pavement management, especially regarding preventive maintenance strategies and offers guidance on how to approach integration using York Region as a case study.
5. Develops a concept decision making framework that demonstrates how safety data should be considered in pavement maintenance decision making at both the network level applying life cycle costs and project level using decision making flowcharts. These tools while specific to York Region can be adopted in jurisdictions with similar characteristics.

The study showed that microsurfacing reduced wet pavement crashes by 32 percent and total crashes by 18 percent. Crashes during dry conditions were reduced by 14 percent. Again, the assumption that all dry pavements have adequate friction is clearly in error. When intersection crashes were analyzed separately, the results showed that microsurfacing could reduce intersection crashes by 24 percent. Also, the study suggests that the microsurfacing treatment can reduce rear end collisions by 29 percent (Erwin and Tighe 2008). The effect of resurfacing showed less significant results but before and after measurements of friction and macrotexture depths were not available to evaluate the relationship between these factors and crash rates before and after the treatments. This information is also critical to making improved decisions.

Summary of Findings and Recommendations – While hazardous driver behavior often contributes to many fatal highway crashes, even criminals are often not given the death penalty, so more forgiving pavement designs and surfaces should be provided. Drivers too often violate design criteria by speeding, driving aggressively, driving under the influence of alcohol or drugs, being inattentive, or becoming distracted. However, even attentive drivers are generally not capable of judging the quality of the friction and texture on the pavement surface. Also, they often fail to slow down significantly during heavy rains where the hydroplaning potential is significantly increased. Providing high-friction surfaces in areas with higher friction demand, can help reduce the severity of injuries or prevent some of these fatalities or serious injuries.

There is a critical need to address friction and texture during mix design procedures particularly for asphalt pavement overlays, microsurfacing, and surface treatments. Some research is underway to help address this issue on Superpave and other mixes. However, the failure of the Superpave mix design procedure to address this issue after 15 years of development is a serious deficiency. This is a significant national research need.

It also suggests that after 40 years of trying to correlate locked wheel skid trailer test data to wet pavement crashes with generally poor results (very low correlation coefficients), there is a definite need for research to develop an improved procedure based on direct measurements of microtexture and macrotexture related to aggregate type, quality and gradation..

There is also a need to conduct studies in other geographic areas to quantify the economic impact on safety of a sound preventive maintenance or pavement preservation program. The evaluation of the benefits of improved friction and macrotexture should be added as a routine part of an effective pavement or asset management program. Quantifying the beneficial effect of pavement preservation on safety was not specifically identified as a CRITICAL research need in the January 2008, *Transportation System Preservation Research, Development, and Implementation Roadmap* (FHWA 2008).

It is recommended that the Regional Pavement Preservation groups conduct pooled funds studies to quantify the safety benefits of resurfacing and microsurfacing or surface treatment projects. In each region, it is suggested that 25-30 resurfacing projects and 25-30 microsurfacing or surface treatment projects be identified for before and after crash studies (ignore the year of construction and use a minimum of three years before and three years after crash data). This analysis could be conducted in a manner similar to the recently completed ODOT Friction Study (Larson et al. 2008). Predictive models should be developed to evaluate the impact of various friction and macrotexture levels on total and wet pavement crash rates so an incremental benefit-cost ratio analysis can be conducted and used during detailed project design. These studies should provide quantifiable data on the safety benefits of quality resurfacing and microsurfacing or surface treatment projects on reducing highway crashes and evaluating the cost effectiveness of the level of friction and macrotexture actually provided.

It is estimated by the author that an effective pavement preservation program could reduce annual fatalities and serious injuries 5 to 20 percent within 5 years. Benefits to costs have ranged from 5 to 1 in the U.K. to 40 to 1 in New Zealand when safer roads management programs have been established (Larson et al. 2008). The U.K. established its program in 1989, and in the period from 1990 to 2008 total fatalities have reduced from 5217 in 1990 to 2645 in 2008 or a total reduction of 49.3 percent.

The publication of the *Guide for Pavement Friction* (in late 2008) and the *Highway Safety Manual* (in early 2010) by AASHTO will provide significant guidance and emphasis on techniques to improve the consideration of highway safety including cost-effective countermeasures. The significant role that improving the pavement surface condition (and particularly increasing friction and macrotexture) can have in reducing the annual number of fatalities and serious injuries should not be minimized. Procedures to quantify the safety benefits are urgently needed. It has been conclusively shown that engineering safer roads can have a dramatic impact on reducing the unacceptable number of annual fatalities and serious injuries (and the associated billions of dollars of cost) on our nation's highways. Clearly, a more proactive approach to engineer safer roads in the U.S. is needed.

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