

TRANSPORTATION RESEARCH DIGEST

February 2010

ARIZONA TRANSPORTATION INSTITUTE

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FEBRUARY 2010

TO: TRANSPORTATION PROFESSIONALS, MANAGERS, & POLICY MAKERS

FROM: ARIZONA TRANSPORTATION INSTITUTE

The volume of information on transportation issues, policies, technologies, and related topics is huge. Not even the most well-read professional can keep up with everything that might be useful to know. The *Transportation Research Digest* series is designed to expedite the transmission of information by condensing and summarizing significant documents. Busy professionals or managers may quickly obtain the gist of new developments and determine whether they need to see the full document.

The *Transportation Research Digest* is not meant to present definitive resolutions of scientific or policy controversies, but contributions to the pursuit of knowledge and the debate of issues. The intent is to be comprehensive rather than conclusive on the multitude of issues and topics of concern to those working in the field of transportation. Readers are encouraged to obtain the original document summarized in the *Transportation Research Digest* and subject the content to their own judgment.

Transportation professionals who would like to recommend documents to be summarized or submit summaries to be considered for inclusion in this publication are invited to do so. To recommend a document please send a copy (or information indicating how a copy can be obtained) of the research report to be summarized. To be considered, the report must meet the following requirements: (1) it is transportation related, (2) it is no more than two years old, (3) there is enough information in the report to warrant a two page summary. To write a summary, insure that the document being summarized meets the above requirements. The summary should be submitted in an electronic format. This summary should be in the 500 to 800 word range and may include tables and/or simple graphics—all of which must fit within the *Transportation Research Digest's* two-page format. Submissions are subject to editing for clarity and length. We do not guarantee that all submissions will be published.

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Transportation Research Digests from December 1995 to November 2003 are available on request.

A “Topic” code in the Table of Contents will help readers more quickly identify items of interest. The topic codes are explained in the table below.

<u>Code</u>	<u>Topic</u>	<u>Code</u>	<u>Topic</u>
ADM	Administration	PLAN	Planning
AIRP	Airports	PRIV	Privatization
AVIA	Aviation	RAIL	Railroads
BIKE	Bicycles	RDS	Roadside
CON	Construction	ROW	Right-of-Way
ECON	Economics	SAFE	Safety
ENV	Environment	STR	Structures
FIN	Finance	TECH	Technology
INOV	Innovations	TOLL	Toll Roads
MAIN	Maintenance	TRAN	Transit
MISC	Miscellaneous	TRF	Traffic
MVD	Motor Vehicle Dept	TRK	Trucking
PAVE	Pavement	VEH	Vehicles

Requests or inquiries may be made via e-mail (jsemmens@cox.net).

Thank you.

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Considerations for Rigid vs. Flexible Pavement Designs when Allowed as Alternate Bids by Andrew J. Wimsatt, Carlos M. Chang-Albitres, Paul E. Krugler, Tom Scullion, Tom J. Freeman, and Maria B. Valdovinos, Texas Transportation Institute, The Texas A&M University System, College Station, Texas 77843-3135 (Texas Department of Transportation, Research and Technology Implementation Office, P.O. Box 5080, Austin, TX 78763-5080; <http://tti.tamu.edu/documents/0-6085-1.pdf>) (Aug 2009)

Highlights

- The main goal of this research was to provide TxDOT with guidelines, including a practical protocol for deciding whether or not to develop pavement structure alternatives for alternate bids.
- Alternate bids should attract more contractors, increasing competitiveness among them with the aim of resulting in lower construction costs.

When Should the Department Consider Alternate Pavement Designs?

It was found in this research that the following characteristics can make a pavement unsuitable for offering alternative pavement designs in the plans. The researchers recommend that these characteristics be incorporated into the DSR:

- This is a pavement widening project.
- The project does not involve new construction or reconstruction.
- The pavement is less than 500 feet in length.
- The pavement is less than 5 miles in length, and both connecting pavements are either rigid or flexible pavements.
- There are areas of the pavement where truck traffic will be stationary for long periods of time.

In addition, the researchers generated two options that can be incorporated in the

DSR revision. The first option states that pavement alternates should not be used if the project's one-way truck traffic ADT value range is below 300 or above 2,000. The second option states that pavement alternates should not be used if the concrete pavement thickness for the project generated from the 1993 AASHTO Guide design procedure is less than 8 inches or 12 inches and greater. This is a preliminary evaluation prior to the design. If this pavement does not include any of the above characteristics, it is recommended to use APDAT to further explore offering alternative pavement designs.

The APDAT decision analysis tool incorporates lower and upper limit ESALs for each district that is based on concrete pavement thicknesses of 8 inches and 12 inches using the appropriate inputs in the 1993 AASHTO rigid pavement design procedure. If the ESALs are outside the districts' limits, the APDAT tool indicates that pavement alternates should not be considered.

If after conducting the preliminary evaluation the pavement appears to be a candidate for alternative pavement design, then alternate designs should be generated. After developing the Flexible and Rigid Pavement Designs, a life-cycle cost analysis of both alternatives is conducted.

If the LCCA difference between the alternatives is more than 20%, the researchers recommend that the engineer should select the

alternative with the lowest life-cycle cost. If the LCCA difference between the alternatives is less than 20%, then alternate pavement design is recommended for the bidding process.

Recommendations for Developing Alternate Pavement Designs

The TxDOT Pavement Design methods, Flexible Pavement System (FPS-19W) and the 1993 AASHTO Guide rigid pavement design procedure should be used for the development of alternative pavement designs. General guidelines currently used by TxDOT concerning the design of pavement alternates for new construction and reconstruction projects are:

- Use 30 years as the design life.
- Use 4.5 and 2.5 for the initial and terminal serviceability values.
- Use 95% reliability.
- Use a time to first overlay of 15 years for the flexible pavement design.
- Design the overall subgrade and pavement structure to have a Potential Vertical Rise no greater than 1.0 inch as calculated by Tex-124-E from soil tests in a soil column 15 feet deep as measured from the proposed finished pavement grade. Alternatively, provide material with an effective Plasticity Index of less than 25, to a depth of 8 feet from finished pavement surface.

The use of life-cycle cost analysis is recommended. An interest rate based on current financial data should be used. For initial construction costs, the designers should use thicknesses generated for flexible and rigid

pavement designs using the recommended design input values developed by TxDOT. For routine maintenance costs, the researchers recommend consulting with appropriate district personnel as to appropriate costs. The researchers analyzed the maintenance costs contained in the Fiscal Year 2008 PMIS database and included it in a separate worksheet; this information can be used as a basis of discussion with district personnel.

For timing and costs related to future asphalt concrete pavement overlays, seal coats, or other surfaces, as well as future patching for rigid pavements, the researchers recommend consulting with appropriate district personnel. In addition, the researchers recommend using information from well-performing projects in their respective areas that are at least 20 years old.

If the designer decides to generate salvage values, the designer will first need to determine if the pavement will need to be removed at the end of the 30-year analysis period. If the pavement structure would be removed, the designer should use the salvage value recommendations in the FPS-19W design program for the flexible pavement design; and determine the value of the concrete pavement design by determining the cost of removal and the cost of new material it could replace in a new pavement structure. If the pavement structure will not be removed, then the salvage value can be simply a function of the cost of a future overlay versus the cost of a new pavement structure. User costs could be considered in the analysis but only if deeper analysis is desired.

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New Approaches to Ecological Surveys, NCHRP Synthesis 400 by Patricia C. Cramer, Utah State University, Logan, Utah (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_400.pdf) (2009)

Highlights

- The future holds many promising new ways to gather data, bring them into common GIS formats, and improved working relations among agencies.

As the world becomes more developed and intact natural resources become more scarce, it will take greater and greater commitments to protect ecological resources. Respondents to this synthesis' survey gave thoughtful responses to how state departments of transportation (DOTs) and natural resource agencies are coping with the challenges of protecting the natural world. The rich diversity of responses from more than 100 survey participants gave a wide spectrum of biological and ecological survey needs, and developing approaches to those needs. The major themes of this synthesis, as developed from those responses and concurrent literature and new initiatives searches are as follows:

1. Transportation planners and their colleagues are moving beyond the traditional framework in the consideration of ecological resources; the 2005 Transportation Act (SAFTEA-LU) encourages and expects this. Long-range transportation planning will consider ecological resources to a greater degree than in past actions.
2. The innovations that assist with the developing broad-scale approach to transportation planning involve new ways of thinking; a paradigm is developing that encompasses broad

biological and landscape scales of viewing the natural world and years' long time frames to detect potential impacts and to create solutions.

3. These large spatial scale and long-term plans and potential solutions require increasingly higher resolution data. These data increasingly need to be in similar formats and easily accessible.

Overall, the survey revealed a wide range of needs and new approaches that involve cooperative coordination among organizations that collect and store data and those who need the data, such as DOTs.

In summary, the future holds many promising new ways to gather data, bring them into common GIS formats, and improved working relations among agencies. The expanded responsibility for transportation agencies to broaden their approach to areas outside the road right-of-way and to consider ecological resources early in planning is the model for change in transportation. This paradigm change began happening in the past decade as state and federal transportation departments became more responsible for the world outside of the road right-of-way. New ways of doing business, such as Context Sensitive Solutions and the provisions of the 2005 Transportation Act (SAFETEA-LU) Sections 6001 and 6002, are becoming more standard. The dozens of responses to this synthesis' survey are reflective of how those within and outside departments of transportation expect these organizations to

operate. An approach to view transportation and the environment in a more holistic manner than traditionally considered will be more common in transportation planning. This expanded vision of responsibility will necessitate more interactions between DOTs and state fish and wildlife agencies. Agencies increasingly will need to be more proactive about identifying areas that state, regional, and local organizations have targeted for development and those areas that need to be avoided, minimized, or mitigated because they are conservation areas. The current initiatives such as Eco-Logical, and the Western Governors' Association Wildlife Corridors are examples of how states and regions of the country are coming together to develop an interagency approach to transportation planning, development, and maintenance. These new ways of doing business will be supported by more standardized Geographic Information Systems data that will be

synchronized among data layers and across agencies. Technological advances in survey methods will become better developed and disseminated.

A promising sign of how ecological survey data will be used proactively to help avoid, minimize, or mitigate environmental impacts is the wealth of responses from the survey respondents. The DOT and fish and wildlife agency professionals who replied to the survey are doing an admirable job at protecting the natural world and finding ways to work together. The general consensus is that it is essential for these professionals to understand what the ecological resources are before they are gone. Judging from the wealth of knowledge and commitment from the survey respondents concerning the natural world, the United States is well on its way to defining how it will protect and restore its ecological legacies.

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Synthesis Study on Variable Asphalt Shot Rates for Seal Coat by Krugler, C.K. Estakhri, C.H. Sasser, C.M. Chang-Albitres, Texas Transportation Institute, The Texas A&M University System, College Station, Texas 77843-3135 (Texas Department of Transportation, Research and Technology Implementation Office, P.O. Box 5080, Austin, TX 78763-5080; <ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/5833.pdf>) (Jun 2009)

Highlights

- All districts currently using transverse variable asphalt rates (TVAR) are fully convinced it is providing improved performance of seal coats.

The Texas Department of Transportation (TxDOT) has for many decades relied heavily on seal coats for preventive maintenance of flexible pavements. The experience and knowledge gained by department personnel over these years have led to numerous improved methods, materials, and equipment. At the time of this study about half of TxDOT's districts were using transverse variation of seal coat asphalt rates as a means of reducing reoccurrence of wheel path flushing and consequent loss of texture and skid resistance. The purpose of this research project was to learn from those districts and prepare guidance for use of this technique on a statewide basis.

The research team searched existing literature and found that researchers in New Zealand have developed equipment and methods for transversely varying asphalt shot rates for chip seals. Their use of this technique is reportedly successful and expanding. They have not, however, developed a refined method for determining the percentage of asphalt rate variation that is appropriate for varying roadway conditions.

All TxDOT district offices were contacted to determine the extent to which

transverse variable asphalt rates (TVAR) were being used in Texas. The districts having the most experience with this technique provided information from their experiences. The research team collected information from nine districts, visiting seven of these districts so that TVAR methods could be observed in the field. A structured interview process facilitated capture of knowledge.

The scope of the project included texture depth testing of selected pavements in three districts prior to application of new seal coats. The research team used the Circular Track (CT) Meter, the Outflow Meter, and the Sand Patch Test methods (see Figure 1) for determining existing wheel path and outside of wheel path textures. Close-up photography documented the relative texture conditions of wheel paths and outside of the wheel paths prior to placement of the new seal coats. The asphalt shot rates selected by the districts for each tested pavement were recorded.

Principal findings included that all districts currently using TVAR are fully convinced it is providing improved performance of seal coats in their districts. They are successfully using TVAR with hot asphalts and emulsions, with Grade 3 and Grade 4 aggregate, with lightweight and natural aggregate, and with precoated and plain aggregate. Most TVAR applications are on previously seal-coated pavements which have visually evident wheel path flushing. Texture differences across asphalt mixture pavements

usually do not vary adequately to warrant use of TVAR. Also, most districts do not use TVAR on shoulders, continuous turning lanes, or with Grade 5 aggregate.

Texture testing results indicated that determining difference in texture across the lane can be helpful in determining when to use TVAR and how much to increase the shot rate outside of wheel paths when TVAR is appropriate. The differences in texture generally correlated to the visually apparent severity of wheel path flushing. However, there were several cases where the testing appeared to identify texture differences that were not easily observed. The Sand Patch Test and CT Meter gave highly correlated test results. The Outflow Meter often provided higher texture test results and did not demonstrate the same level of sensitivity as that provided by the other two testing methods. The low cost and simplicity of the Sand Patch Test make it the logical choice for use in the field to assist in selecting TVAR asphalt variations for specific roadway conditions.

Guidelines are now available, which will be especially useful for districts currently not using the TVAR technique. All districts now have a quantitative testing procedure that can be used in addition to visual appearance of the roadway when determining whether or not to transversely vary the asphalt shot rate, and how much to vary it when the decision is to do so. A spiral-bound field guide has been published and is being distributed at five regional workshops during the spring of 2009. Districts will be trained in the TVAR technique and the use of the Sand Patch Test for TVAR

determination. Each district will receive a Sand Patch Test kit during this series of workshops.



Figure 1: Sand Patch Texture Testing

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Alternatives Weigh-in-Motion (WIM) Plan for Statewide Data by E.G. Fernando, D.R. Middleton, T.B. Carlson, L. Ruback, E.D. Sepulveda, R.R. Longmire, T.J. Freeman, J.H. Oh, Texas Transportation Institute, The Texas A&M University System, College Station, Texas 77843-3135 (Texas Department of Transportation, Research and Technology Implementation Office, P.O. Box 5080, Austin, TX 78763-5080; <ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/5551.pdf>) (Aug 2008)

Highlights

- Most states use bending plates, load cells, piezoelectric sensors, and Kistler quartz sensors at WIM installations.
- Solar panels provide a viable alternative in the absence of land lines.

The strategic plan for establishing a vehicle weight monitoring net across Texas prefers deploying WIM installations on 500-ft continuously reinforced concrete pavements (CRCPs). While these pavements have, from experience, provided suitable stable foundations for WIM sensors, building a short CRCP slab specifically for a WIM is expensive. This project aimed at finding less costly but equally viable alternatives for deploying WIM installations by developing guidelines for finding sections within existing asphalt concrete pavements that provide the level of smoothness, pavement support, and projected service life deemed suitable for WIM sites, particularly for installations that use piezoelectric technology.

Researchers carried out a comprehensive work plan that covered the following tasks:

- review of current WIM practices,
- field and laboratory tests and data analyses to establish guidelines for identifying suitable WIM locations on asphalt concrete pavements,
- investigation of WIM applications of solar power and wireless

- communications, and design and installation of a wireless setup,
- installation monitoring of an actual WIM site to document the procedures for placing quartz WIM sensors on asphalt concrete pavements, and
- roundtable discussions to identify user requirements for truck weight data.

Researchers note the following findings:

- Most states use bending plates, load cells, piezoelectric sensors, and Kistler quartz sensors at WIM installations. Proper installation on pavements that provide adequate support appears to be a key factor in getting good load sensor performance and service life.
- To date, the limited experience with Kistler quartz sensors in Texas has generally been good.
- The review of WIM practices did not identify any new and innovative low-cost WIM sensor that can be recommended for practical use at this time in a state WIM network.
- Solar panels provide a viable alternative in the absence of land lines.
- The WIM smoothness criteria in the provisional American Association of State Highway and Transportation Officials (AASHTO) MP-14 specification generally produced inconclusive determinations of whether

a WIM installation classifies as Type I for the TxDOT WIM sites tested in this project.

- Researchers identified the following potential applications of the falling weight deflectometer (FWD) for maintenance of WIM sensors: 1) as a tool to check the linearity of the WIM response to applied loads, and 2) as a tool to check the consistency in the WIM readings from repeat measurements at a given drop height. However, more work is needed before any definitive conclusions can be made for using the FWD to perform checks on existing WIM systems.
- FWD deflections taken on the 500-ft perpetual pavement WIM sections south of Cotulla show the uniformity and degree of pavement support to be comparable to that provided by CRCP. Data from tests conducted with a calibration truck also showed no significant correlation between pavement temperature and measurement errors of gross vehicle weight for the quartz WIM sensors installed on the perpetual pavements at the site.
- Using the guidelines from this project, researchers found an acceptable flexible pavement WIM site located within the limits of a recently completed rehabilitation project along I-10 west of Balmorhea. TxDOT installed a Kistler

quartz WIM system on the selected site during this project.

- Based on the roundtable discussions conducted with TxDOT, researchers are of the opinion that the Statewide Traffic Analysis and Reporting System (STARS 2) provides the main opportunity to improve current internal procedures for summarizing and reporting truck weight data.

Considering the above findings, researchers offer the following recommendations:

- TxDOT should implement the proposed guidelines to locate suitable asphalt concrete pavement sections for WIM installations.
- TxDOT should consider funding a contract to support implementation of the flexible pavement WIM evaluation guidelines as part of its ongoing effort to establish a state highway WIM network.
- TxDOT's Transportation Planning and Programming Division (TPP) should continue its efforts to install cost-effective WIM technology that does not result in degradation of data quality.
- TPP should make efforts to include divisions and sections of TxDOT and other state agencies that use or desire to use WIM data in the development of STARS 2.

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Modeling the Transportation Impacts of Smart Growth Development in Maine (University of Vermont Transportation Research Center, Farrell Hall, 210 Colchester Avenue, Burlington, VT 05405; Phone: (802) 656-1312; <http://www.uvm.edu/~transctr/pdf/Smart-Growth-in-Maine.pdf>) (Aug 2009)

Highlights

- Smart growth could reduce daily traffic volume by as much as seven-tenths of one percent. & air pollution by as much as six-tenths of one percent.

This study evaluates the reductions in average trip lengths, daily vehicle miles traveled (VMT), and daily greenhouse gas (GHG) emissions from on-road automobiles due to smart growth development strategies in two Maine towns, Lisbon in Androscoggin County and Sanford in York County. The future analysis year is 2030 and considers levels of household and employment growth expected in the two towns.

Three growth scenarios are analyzed. The Status Quo Growth scenario considers future growth following historical land use patterns in Lisbon and Sanford, based on linear growth assumptions. The first smart growth scenario, Targeted Smart Growth, redirects a portion of household and employment growth into one dense, mixed-use infill development, within an assumed growth boundary in each town. The second smart growth scenario, Multiple Smart Growth, is a more rigorous version of Targeted Smart Growth by redirecting a greater amount of growth into two smart growth developments in Lisbon and three smart growth developments in Sanford. In Lisbon, 100 households and 101 jobs are redirected for Targeted Smart Growth, and a total of 239 households and 139 jobs are redirected for Multiple Smart Growth. In

Sanford, 358 households and 561 jobs are redirected for Targeted Smart Growth, and a total of 859 households and 852 jobs are redirected for Multiple Smart Growth.

Each smart growth scenario is modeled using travel demand forecasting techniques, and the resulting average trip lengths, VMT, and GHG are compared across the three scenarios. Table ES-1 summarizes the VMT and GHG reductions under the smart growth scenarios in Lisbon and Sanford.

In Lisbon, VMT and GHG emissions estimated for the Targeted Smart Growth scenario were 0.43% and 0.42% lower, respectively, than estimates for the Status Quo scenario. The VMT percent reduction corresponds to 656 fewer vehicle miles traveled daily in the Town of Lisbon. Under the Multiple Smart Growth scenario, the reduction in network-wide VMT and GHG emissions was approximately 0.68% and 0.57%, respectively, compared to Status Quo. The VMT percent reduction corresponds to 1,038 fewer vehicle miles traveled daily.

In Sanford, VMT and GHG emissions estimated for the Targeted Smart Growth scenario dropped by 0.24% and 0.27%, respectively, from the Status Quo scenario. The VMT percent reduction corresponds to 985 fewer vehicle miles traveled daily in the Town of Sanford. Under the Multiple Smart Growth scenario, the reduction in network-wide VMT and GHG emissions was approximately 0.42% and 0.43%, respectively, compared to Status

Quo. The VMT percent reduction corresponds to 1,698 fewer vehicle miles traveled daily.

In summary, analysis results for Lisbon and Sanford indicate that:

- The densification and mixing of residential and employment growth as infill developments has a slight but observable impact on VMT and average trip lengths.
- The scenario with multiple smart growth developments had greater benefit, in the form of VMT and GHG reductions, than the scenario with one smart growth development.
- Intra-zonal trips tend to increase for smart growth zones, while the number of intrazonal trips for non-smart growth zones decreases, albeit at varying degrees depending on the land use mix of those zones.
- Some roadways in the towns experienced VMT increases, which were offset by greater VMT reductions on other roadways, resulting in net, network-wide VMT reductions.
- The effect of increases in VMT on some roadways to/from the smart growth developments should be considered when performing detailed planning of such developments.
- The smart growth scenarios are limited to the amount of growth expected in Lisbon and Sanford by the year 2030; greater benefits in VMT and GHG reductions may be more apparent at a later forecast year when more growth could be redirected to smart growth developments.

- Indicating potential for further research, a general estimation shows that greater reductions in VMT and GHG emissions could be attained through an increased share of daily transit trips by providing new transit service to/from the smart growth developments along existing transportation corridors.

It should be noted that only the location, density, and mix of growth were modified across the planning scenarios in the study. Household characteristics, such as size and auto availability, were held constant so that each scenario had similar numbers of daily trips. Use of alternative transportation modes was also held constant, so that there was equal automobile use in each scenario.

Importantly, the study results do not include the effect of future transit service coupled with the proposed smart growth developments. Consequently, the results indicate that the efficacy of the smart growth scenarios to reduce VMT in Lisbon and Sanford is greatly limited without transit to complement the proposed dense, mixed-use developments. One premise of the smart growth scenarios is that the proposed infill developments would be “transit-ready” along existing transportation corridors – Route 196 in Lisbon and Route 109 in Sanford. The smart growth scenarios partially prepare future development for more efficient and viable land use interconnectivity with transit, but transit would also be needed to fully realize this benefit and provide further reductions in daily VMT.

TRANSPORTATION RESEARCH DIGEST

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In-Service Evaluation of Major Urban Arterials with Landscaped Medians, by Peter M. Briglia Jr., Zachary N. Howard, Emily Fishkin, Mark E. Hallenbeck, Anna St. Martin, Washington State Transportation Center (TRAC) University of Washington, Box 354802 University District Building; 1107 NE 45th Street, Suite 535 Seattle, Washington 98105-4631 (Research Office, Washington State Department of Transportation, Transportation Building, MS 47372, Olympia, Washington 98504-7372; <http://depts.washington.edu/trac/bulkdisk/pdf/636.2.pdf>; Proj Mgr: Rhonda Brooks, 360-705-7945) (Jul 2009)

Highlights

- ❑ Installation of landscaped medians can be expected to reduce overall accidents without increasing specific types of accidents.
- ❑ The installation of these medians did not show any beneficial effect on the rates of pedestrian or bicycle accidents.

Because of undesirable characteristics of some major arterials such as State Route (SR) 99 north and south of Seattle, several cities are implementing redevelopment plans. These redevelopment proposals include landscaped medians, many with trees placed close to the roadway. However, WSDOT's clear zone width criterion may not always be met when trees are placed within curbed medians. To address this potential conflict, WSDOT chose to adopt an in-service evaluation process that would let the cities install the medians while it studied collision, environmental, operational, and maintenance experiences in the field.

A report was prepared in 2007 that summarized an analysis of two of the 13 median treatment projects. That report also provided before data and condition information on all median sections. This report summarizes the analysis of five additional sections. Because of changes in the methodology, previously reported accident rates were recalculated to be consistent with the after data from this analysis.

Data from these before and after periods were also analyzed at two control locations where no median treatments were installed. Center two-way, left-turn lanes remained in operation on these control sections.

Overall, fatal, fixed object, pedestrian/bicycle, tree, curb/median and U-turn accident rates were analyzed. The percentages of intersection-related, driveway-related, and other accidents were analyzed. Overall accidents decreased significantly for the combined treatment locations, but no other types of accidents showed significant changes at either the treatment or the control locations, except for the percentage of other types of accidents at the control locations, which increased significantly. An analysis of overall accident rates by segment indicated significant decreases at three of the five treatment locations, whereas the changes at the other treatment locations and the control locations were not significant.

Given the data, it appears that the installation of landscaped medians can be expected to reduce overall accidents without increasing specific types of accidents, such as curb/median or tree accidents, that might be expected to increase as a result of placing fixed objects in proximity to the roadway. Unfortunately, the installation of these medians did not show any beneficial effect on the rates of pedestrian or bicycle accidents, which might

have been expected to decrease with the addition of a refuge area in the middle of the roadway.

These conclusions are consistent with those of the first phase. The Phase 1 study noted a shift in accident location, with fewer mid-block accidents occurring while the number of intersection accidents increased. Similar accident location shifts occurred in this study, but they were not statistically significant. The Phase 1 study found an increase in U-turn accidents in the after period. U-turn accident rates also increased in this study, but the increase was not statistically significant.

Interviews were conducted with three local agencies: Federal Way, Mukilteo, and Shoreline. City staff had positive comments about the landscaped medians. Their communities and elected officials were pleased with the improved aesthetics and local “Main Street” feel. In general, agencies reported that they had learned that aesthetics can be improved without affecting transportation service. This has been a paradigm shift for many road designers, and the cities plan to, or would like to, install more of these median treatments.

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Managing the Movements of Hazardous Material Shipments Through Texas Population Centers
by J.E. Warner, C.A. Morgan, D.L. Jasek, J. Huang, A.A. Protopapas, Texas Transportation Institute, The Texas A&M University System, College Station, Texas 77843-3135 (Texas Department of Transportation, Research and Technology Implementation Office, P.O. Box 5080, Austin, TX 78763-5080; <ftp://ftp.dot.state.tx.us/pub/txdot-info/rti/psr/5929.pdf>) (Apr 2009)

Four Strategies Were Outlined

- ❑ Route and/or Operational Strategies – such as designating hazardous materials routes,
- ❑ Planning Strategies – such as land use planning and corridor management and preservation,
- ❑ Safety Strategies – such as alternatives to hazardous materials, and
- ❑ Infrastructure Strategies – such as relocating rail operations to new infrastructure.

Vital aspects of everyday life depend heavily on products officially classified as hazardous materials. The term “hazardous materials” generally refers to hazardous substances such as petroleum, natural gas, synthetic gas, acutely toxic chemicals, and other toxic chemicals. Their uses range from everyday household and personal uses to industrial production at various stages – for example, drinking water purification and automotive fuel.

Every day almost a million shipments of hazardous materials move safely and securely along our nation’s transportation system, via any combination of modes. Only a small fraction of total shipments interrupt their planned journey due to an incident that may severely threaten public and environmental safety. However, this threat of very severe, sometimes even catastrophic, consequences – while rare – elevates the concern over transportation of hazardous materials through population centers. Furthermore, concern now

exists over possible intentional hazmat releases as a means to invoke human, economic, and environmental damage.

It is vital for the transportation planning community at all levels to fully understand methods to effectively manage the movement of hazardous materials, thereby improving prevention and mitigation operations, increasing safety, and reducing risk without undue burden to commerce.

This research project accomplished the following activities:

- examined the quantities, origins, and destinations of hazardous materials flows in Texas by mode of transportation,
- reviewed the respective roles of stakeholders,
- investigated the hazmat route relocation potential of multimodal corridors and other rail routes, and
- provided guiding principles on effective state and sub-state strategies for the management of hazardous materials movements.

Flammable liquids such as crude oil, diesel fuel, and gasoline represent the largest hazardous materials class of products transported nationally and in Texas. Gases, such as chlorine used in drinking water purification, placed a distant second, while the remaining hazardous materials made up less than 10 percent of the total tons shipped.

In Texas, all modes are active in the transport of hazardous materials. Almost exclusively moving hazardous materials, pipelines stretch throughout the state and connect Texas to the rest of the nation and even Mexico and Canada. Following pipeline volumes, trucks play a major role in virtually every hazardous materials commodity. Additionally, rail and marine contribute significantly in the movement of hazardous materials, including such commodities as basic chemicals.

The research team determined several management strategies available to communities and planners. Generally these strategies fall within four categories:

- Route and/or Operational Strategies – such as designating hazardous materials routes,
- Planning Strategies – such as land use planning and corridor management and preservation,
- Safety Strategies – such as alternatives to hazardous materials, and
- Infrastructure Strategies – such as relocating rail operations to new infrastructure.

The conclusions for this research project include:

- The public is largely unaware of their coexistence with hazardous materials on a daily basis.
- Generally, hazmat will – and in most cases must – pass by and through communities to reach the ultimate consumer.
- Many actions to reduce the risk or improve safety exist or are possible in various ways, such as alternative processes or chemicals.
- Freight planning initiatives nationally and statewide are enhancing and will continue to enhance safe and efficient movement of hazardous materials.
- National and state hazard management activities provide a good framework for agencies to work together to reduce all hazard risks, including hazardous materials.

A guidebook of management strategies is being developed under this project. It will provide tools and activities that planners at all levels can utilize to reduce the potential negative effects of shipping hazardous materials through urban centers. Additionally, planners and officials will be able to utilize the data evaluation to better understand the overall movements of hazardous materials in Texas.

TRANSPORTATION RESEARCH DIGEST

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Cathodic Protection for Life Extension of Existing Reinforced Concrete Bridge Elements, NCHRP Synthesis 398 by Ali Akbar Sohanguhpurwala, Concorr, Inc., Sterling, Virginia (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_398.pdf) (2009)

Highlights

- The primary goal of this synthesis is to examine the utility of this technology for controlling corrosion on reinforced concrete structures.

Over the past three decades significant attention has been focused on the condition of the nation's aging highway bridge infrastructure. As the cost of maintenance and replacement continues to increase, many agencies are looking for materials and technologies to preserve their infrastructure and extend their service life. To address the corrosion problem on reinforced concrete structures, a research and development effort was initiated by both the private and the public sectors in the early 1970s. Numerous different technologies were introduced to repair damage caused by corrosion and to prevent or minimize further damage from occurring. During this time cathodic protection, one of the most effective technologies to stop corrosion, was adapted for implementation on reinforced concrete structures. In 1982, an FHWA Policy Statement reported that cathodic protection is the only technology that can directly stop corrosion in reinforced concrete structures and this statement is still valid today.

Since its first application on a bridge deck in 1973, many different types of systems have been developed and a significant amount of literature on their performance is available. Certain types of cathodic protection systems are projected to provide service-life extensions

in the range of 25 to 50 years, and presently there are systems that have been in operation for 20 or more years.

The primary goal of this synthesis is to examine the utility of this technology for controlling corrosion on reinforced concrete structures and determine, if possible, why public agencies do or do not use this technology and explore how to encourage expanded appropriate use of this technology. To accomplish the goals of this project a survey of state and provincial departments of transportation (DOTs) and the industry was conducted. A total of 37 responses were received from public agencies, 32 of which were from U.S. state DOTs and 5 were from Canadian provincial DOTs. Responding states include all with 10 or more cathodically protected bridge decks, according to the National Bridge Inventory. A literature survey was also performed to obtain information on practices and experience with the use of this technology. The results of this exercise are documented in this report.

Agencies that have adopted this technology as one of the tools for bridge preservation and have developed in-house procedures, protocols, and acquired the technical skills to implement it have experienced reductions in maintenance frequency and costs and have achieved significant service-life extensions. In some cases, service-life extensions of more than 20 years have already been achieved, and those structures are not expected to have corrosion-

induced damage as long as the cathodic protection systems are functional. However, only three states in the United States—Florida, Missouri, and Oregon and three Canadian provinces—Alberta, New Brunswick, and Ontario, have adopted this technology and are actively implementing it. Many other agencies have experimented or implemented the technology on select projects and have not made a commitment to implement it on a larger scale.

Some agencies' experience with the technology has not been satisfactory. Often, these agencies did not have the expertise or resources to evaluate, select, design, install, and monitor and maintain the systems. Many of these systems were not properly selected, had deficient design, substandard installation, and insufficient or no monitoring and maintenance. At least one agency has indicated that although they had actively installed cathodic protection systems on their bridge structures in the 1980s, currently they do not have an inventory of the systems or any information on the status of the systems; those systems have been forgotten. Some failures were simply a result of the expansive growth the industry experienced in the late 1970s and the 1980s, and it took the marketplace some time to weed out the less effective and less durable systems. The survey data suggest that insufficient or no monitoring and maintenance is being performed by many agencies and it is the most important reason for

the disappointing performance of many of the systems.

There are many agencies that can benefit from this technology but have not adopted it primarily owing to the high initial cost, inadequate resources to monitor and maintain the systems, lack of understanding of the technology, and lack of innovation and competition. Of the agencies that have never used or have not used cathodic protection since 2003, 18 indicated that they would consider it in the future. These agencies may need Standard Specifications for selection, design, and construction of these systems and protocols for monitoring and maintenance. Their staff may need to be trained in the implementation of the technology. The FHWA or the National Association of Corrosion Engineers may need to develop a document that public agencies can use to properly implement the technology. The National Association of Corrosion Engineers and/or the National Highway Institute may need to develop and conduct training classes to ensure that agencies have staff with the requisite skill sets. In addition, innovation and competition in the marketplace is lacking and the industry needs to determine a way to provide innovative products at competitive prices. Many agencies appear to favor the galvanic systems that require comparatively less monitoring and maintenance than the impressed current systems, and innovation in this area would be beneficial for the growth of the industry.

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Practical Measures to Increase Transit Advertising Revenues, TCRP Report 133 by Jane Alpers, Denneen & Company, Boston, MA (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_133.pdf) (2009)

Highlights

- Transit advertising has serious image and product deficiencies.
- The level of product innovation is insufficient to generate interest and enthusiasm among media planners and advertisers.

Transit Advertising's Positioning Is Neither Highly Motivating nor Differentiated from Billboards

The media planner study showed that what is perceived to be unique about transit media is its ability to reach a captive audience. This second tier positioning was echoed by the finding that transit was viewed by the majority of media planners as a supplemental medium. In addition, transit is viewed as being very similar to billboards in terms of usefulness in a media plan. Both platforms extend reach and frequency, achieve market saturation, and break through clutter. However, billboard advertising consistently scores higher than transit in its ability to achieve these media and marketing objectives.

Transit Advertising Has Serious Image and Product Deficiencies

The majority of media planners in the study said they are very familiar with transit advertising and have had good experiences with transit advertising. However, transit advertising has a credibility problem. Forty-two percent said that “effective”—the most fundamental requirement for any medium—is

not highly descriptive of transit advertising. Sixty-two percent of respondents said “efficient”—the second most fundamental requirement for a medium—is also not highly descriptive. These are high percentages of media planners who are clearly not convinced that transit advertising works or is worth the money.

The Level of Product Innovation Is Insufficient to Generate Interest and Enthusiasm among Media Planners and Advertisers

The media planner survey showed that transit media are not widely viewed as innovative, hip or sexy. Bus wraps and station dominations are the right idea—high impact, attention grabbing and show stopping. However, these products do not define the entire medium. The new product ideas that rose to the top of the media planner study involved digital technology: digital displays on platforms and in stations, as well on buses and trains. In interviews with advertising sales contractors, there was some mention of exploratory work in the digital realm, especially among the larger contractors.

Aside from Sales Activities, There Is No Promotion of the Product to its Target Audiences

Target audiences need to hear marketing messages—the high level benefits associated with purchasing or consuming the brand, as expressed in the positioning

statement—as well as sales messages—the detailed features and specifications of the product. To the knowledge of the research team, there is little communication of transit’s benefits, aside from what individual transit sales representatives convey. Certainly, there is no single message being consistently conveyed. Nor did the interviews surface any other promotional activities intended to generate awareness of or interest in transit media among media planners and advertisers.

Transit Agencies Not in Top 20 Media Markets Face Greater Obstacles to Growth than Those in the Top 20

General estimates hold that 40% of transit media is purchased by national advertisers and 60% is purchased by local/regional advertisers. The opportunity to sell more transit advertising to national advertisers is great: national advertisers are putting more and more marketing dollars into non-traditional media. For non-top 20 markets, however, the upside potential is less clear. These cities are typically not highly in demand by national advertisers. The generalist media planners who work for local and regional advertisers have the least favorable views of transit media. And the advertising assets, themselves, most likely cover the spectrum from very attractive (e.g., a highly populous second-tier city with a large bus system) to not-very attractive (e.g., a very limited bus system serving a widespread rural population).

Transit Advertising Sales Materials Are Not as Effective as They Could Be at “Making the Case”

An important finding regarding the sales process is that media planners’ needs for demographic data on target audiences and other selling materials are not being met. Lack of demographic data ties to the lack of an audience measurement system, and is a serious deficiency for transit advertising, affecting its credibility and therefore its usage. Lack of other selling materials is an issue for individual transit media sales representatives, who would benefit from support from an industry-wide marketing resource.

The Overall Level of Satisfaction with Transit Media Sales Representatives Is Low

Media planners find transit sales representatives, on the whole, to be knowledgeable, responsive and reliable. Media planners give transit sales representatives credit for taking time to understand the business issues that the media planners are trying to address, rather than going straight to space availability and pricing. However, when asked about their overall satisfaction with transit sales representatives, media planners’ scores are low. Also, the 52% of respondents who have sales representatives that sell transit along with other media are significantly less satisfied than the 48% of media planners with transit-only sales representatives.

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Gridlock: Why We're Stuck in Traffic and What to Do about It by Randal O'Toole (Cato Institute, 1000 Massachusetts Avenue, N.W., Washington D.C. 20001-5403; ph 202-842-0200; <http://store.cato.org/index.asp?fa=ProductDetails&method=cats&scid=17&pid=1441451>) (2009)

O'Toole recommends that the government:

- ❑ Base the distribution of federal funds on state and local user fees.
- ❑ Insist that programs aimed at saving energy and reducing environmental effects of transportation be cost-efficient.
- ❑ Create a citizen enforcement process to ensure that federal funds are efficiently spent.

Traffic congestion today is five times worse than it was 25 years ago, yet many transportation planners believe it's their job to make congestion worse in order to encourage people to use mass transit. In his new book, *Gridlock: Why We're Stuck in Traffic and What to Do about It*, Randal O'Toole makes the case for reducing congestion by improving methods of transportation that will increase everyone's mobility and pay for themselves, whether it's cars, buses, planes, or trains.

O'Toole explains that our nation is currently at a crossroads, writing: "We can spend tens or hundreds of billions of taxpayer dollars on transportation projects that sound good but really serve only a small elite. Or we can restore a user-fee-driven system that will continue to improve personal mobility and reduce transportation costs for generations to come."

As one of the nation's most outspoken critics of rail transit projects, O'Toole writes extensively about why rail is often a bad idea. He compares Europe and Japan's rail systems to that of the U.S., resulting in a list of "Six Reasons Cities Should Not Build Rail."

Noting that President Obama has stated that he wants to rebuild America, *Gridlock* examines his options. O'Toole writes that the options are a "user-fee-funded highways...used by most Americans almost every day" or a "high-speed rail...regularly used by only a small fraction of Americans, but the cost would be born by everyone." To O'Toole, the choice is obvious.

The recent economic crisis provides new arguments for both sides. Advocates for rail projects say that increased spending on rail "will provide an economic stimulus to help the nation recover." Those opposed say that "the nation needs to invest its limited resources wisely to improve productivity and minimize waste."

Gridlock presents a wide range of ideas and policy recommendations on how to move forward into the transportation system of the future. In order to take the politics out of transportation, O'Toole recommends that "the best thing Congress can do is to turn over all surface transportation funding and decision making to the states."

In addition, O'Toole recommends that the government take three key steps:

1. Base the distribution of federal funds on state and local user fees.
2. Insist that programs aimed at saving energy and reducing environmental effects of transportation be cost-efficient.
3. Create a citizen enforcement process to ensure that federal funds are efficiently or cost-efficiently spent.

In addition to extensively analyzing conventional transportation issues, O'Toole offers compelling looks at what may initially seem to be unconventional solutions-ones that prove to be highly compelling and plausible. For example, one of the more thought-provoking chapters, "Dude, Where's My Driverless Car?" makes the case that driverless vehicles are "the next transportation revolution." O'Toole points out that the advantages of such a system are considerable,

and include "four times the capacity for a given roadway, higher average speeds, increased safety, and reduced energy costs."

O'Toole begins the book by tracing the history of American mobility, from waterways to railroads and cars, showing where the great-improvements in transportation occurred and what their impact on society was. As O'Toole states, "Understanding that transformation provides the keys to promoting mobility in the 21st century."