

TRANSPORTATION RESEARCH DIGEST

DECEMBER 2009

ARIZONA TRANSPORTATION INSTITUTE

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TRANSPORTATION RESEARCH DIGEST

ARIZONA TRANSPORTATION INSTITUTE

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DECEMBER 2009

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.

If you would like to obtain the full report upon which a *Transportation Research Digest* summary is based you have several options. Check your local university library. You may want to contact the publisher using the contact information appearing in the *Transportation Research Digest*. Some of the documents are free for the asking. Others can be purchased.

There is a database listing of all the previously published *Transportation Research Digests* that we have on file (back to 1984). Copies of the list or of portions of the list selected by topic or mode can be provided on request. You may also access the database via the internet at

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	RDSO	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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Evaluation of the Use of Snowplowable Raised Pavement Markers by K. R. Agent and E.R. Green, Kentucky Transportation Center, College of Engineering, University of Kentucky, Lexington, Kentucky 40506-0281 (Kentucky Transportation Cabinet, 200 Mero Street, Frankfort, Kentucky 40622) (Apr 2009)

Highlights

- ❑ The crash rate was lower on the RPM system on rural, two lane roads compared to similar roads not on the system.
- ❑ Durability problems with castings were primarily the result of the pavement condition.
- ❑ Rumble strips should only be placed on new pavements.

The objective of this study was to evaluate the effectiveness and durability of snowplowable raised pavement markers (RPM) installed on the RPM system in Kentucky. The durability evaluation dealt with the marker housing.

An analysis of crash data on rural, two-lane roads found the crash rate was lower on the RPM system on rural, two lane roads compared to similar roads not on the system. Also, the percentages of nighttime and wet, nighttime crashes were slightly lower on RPM system roads.

A comparison of crashes before and after installation of centerline rumble strips found that total crashes decreased as well as crashes involving a head on or "opposite direction sideswipe" collision. Also, crashes during darkness (including wet pavement) decreased. The number of snow and ice related crashes and motorcycle crashes did not increase, and those types of crashes occurring after the installations were not related to the centerline rumble strips.

A survey of the durability of marker castings found that, on asphalt pavements, about 4.5 percent of the castings were missing. There was a range in the percent missing with about 11 percent missing on roads with a pavement over 12 years old and about 30 percent missing on asphalt pavements rated as in poor condition.

Durability problems with castings were primarily the result of the pavement condition. No significant problems were found with the installation process. The data show that it should be expected that some marker castings will be removed as a part of snowplow operation but the losses can be kept to a minimum if the installation process is carefully monitored and the markers and pavement are routinely inspected to ensure they remain secure.

The data show that continued use of snowplowable raised pavement markers can be justified if the markers are properly installed (on new pavements only) with a commitment that the pavement will be maintained. When the lenses are replaced (on an approximate three-year cycle), the castings should be inspected with any loose markers removed.

Using the installation cost along with the cost of lense replacement on a three-year cycle results in a total cost of about \$30 per marker over a 15 year pavement life. Using the marker spacing results in a cost of about \$4,000 per mile for the life of the pavement to install and maintain the markers. This is a very small cost compared to the paving cost.

Centerline rumble strips should be considered on rural, two-lane roads with 12-foot lane widths and paved shoulders. The rumble strips should only be placed on new pavements.

An evaluation of alternative snowplowable marker designs and wet reflective tape should be conducted to determine if they could provide adequate reflectivity with improved durability compared to the currently used snowplowable marker.

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The Effects of Transportation Corridors' Roadside Design Features on User Behavior and Safety, and Their Contributions to Health, Environmental Quality, and Community Economic Vitality by Elizabeth Macdonald, Rebecca Sanders & Paul Supawanich (University of California Transportation Center, 2614 Dwight Way, 2nd Floor, Berkeley, CA 94720-1782; <http://www.uctc.net/papers/878.pdf>) (Nov 2008)

Highlights

- The findings indicate a need to rethink the way highways are currently designed.
- Roadside landscaping was generally found to improve highway safety.
- Posted speed limit signs appear to be limited in efficacy.
- Traffic calming was found to be an effective way to increase pedestrian safety.

The research reviewed in this report examined multiple features of transportation corridors, and how those features affect traffic safety for drivers, pedestrians and bicyclists, walkability and physical activity, emotional health of passers-by, residents, and visitors, the local environment, and the economic vitality of the community. The findings generally indicate a need to rethink the way highways are currently designed – an effort that dovetails well with Caltrans' policy on Context Sensitive Solutions. Several themes emerge from the literature:

Driver Safety

Roadside landscaping was generally found to improve highway safety, but the literature is unsettled about the danger versus benefits that roadside trees pose to those driving along the roadway, and researchers debate how to interpret crash statistics. Many of the comparative crash rate studies that found roadside trees to be associated with higher numbers of crashes did not analyze vehicle

speed data, while the studies that did incorporate speed data generally found that many collisions involving trees also involved speeding, calling into question the "fault" of the tree. Aggregated, these findings suggest that current highway design guidelines may be missing key opportunities to improve traffic safety, and underscore the importance of highway design to communicate appropriate speed, as posted speed limit signs appear to be limited in efficacy.

Pedestrian Safety

The cumulative research on pedestrian safety is more straightforward, although there is some ambiguity about how well site-specific case study findings can be generalized. In general, traffic calming was found to be an effective way to increase pedestrian safety, but the efficacy of the treatments depends largely on the urban context and amount of pedestrian activity and automobile traffic. Although many studies conclude that speed humps are the most reliable method of slowing traffic, other measures, such as center medians, traffic circles, and roadway narrowing appear to be effective in certain circumstances. The research was clear that there is no one-size-fits-all traffic calming treatment, but that a combination of pedestrian safety enhancements, when thoughtfully implemented, holds promise for improving pedestrian safety.

The research on crosswalk design and pedestrian safety is more conclusive. Several

pieces documented that pedestrians often have a false sense of security at marked but unsignalized crosswalks, leading them to be less cautious of passing traffic than they perhaps should be. Other pieces documented that many drivers often ignore pedestrian right-of-way rules and fail to stop for pedestrians waiting at crossings. The general conclusion, therefore, was that at unsignalized crossings, crosswalk markings should be installed along with ancillary traffic calming techniques, such as flashing in-pavement lights, red or flashing beacons, a speed table, or bulb-outs, to give the driver extra alerts and to enhance pedestrian visibility.

Physical Activity and Walkability

Another theme, as expressed in the literature on walkability and its connection to physical health, is that walkability is influenced by the connectivity of streets, provision of sidewalks, and design of the neighborhoods and roadways as well as by a mix of land uses. The literature also suggested that those who live in walkable neighborhoods walk more than those who do not.

Bikability

Research completed to date indicates that well marked on-street bicycle lanes tend to be preferred by the majority of bicyclists, and may even encourage more people to cycle.

Psychological Well-being

Time spent viewing greenspace or being outside in a calm environment enhanced

positive feelings both directly and indirectly by taming stress and frustration, and was associated with improved performance on subject tests. In particular, the presence of roadside landscaping has been tied to reduced traffic stress for both drivers and those who live along heavily traveled corridors.

Community Economic Vitality

There is not much literature on the relationships between corridor design elements and community economic vitality. However, the research that has been done indicates that the presence of landscaping and trees generally improves property or rent values and attracts people.

Environmental Effects

The theme throughout the environmental literature was that trees in urban areas tend to be overwhelmingly beneficial for communities. In particular, urban trees help reduce energy consumption, mitigate urban heat island effects, retain stormwater, and mitigate air pollution. Some research studies found that urban street trees that shade both buildings and paved surfaces make important contributions to energy savings, emission reduction, and heat island mitigation. In addition, the shade from trees prolongs material life, such as roadway slurry seals. The literature strongly suggests that careful street tree selection is important, as the greatest tree benefits come from those species that are deciduous, fast-growing, tall, broad-canopied, and low VOC emitters.

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Federal Requirements for Highways May Influence Funding Decisions and Create Challenges, but Benefits and Costs Are Not Tracked (Government Accountability Office, 441 G St., NW, Washington, DC 20548; <http://www.gao.gov/new.items/d0936.pdf>; David J. Wise at (202) 512-2834 or wised@gao.gov) (Dec 2008)

Highlights

- State officials said that they use nonfederal funds for certain projects to avoid project delays or costs associated with the federal requirements.

Why GAO Did This Study

As highway congestion continues to be a problem in many areas, states are looking to construct or expand highway projects. When a state department of transportation (DOT) receives federal funding for highway projects from the Federal Highway Administration (FHWA), the projects must comply with the National Environmental Policy Act (NEPA), the Davis-Bacon prevailing wage requirement, the Disadvantaged Business Enterprise (DBE) program, and the Buy America program. While complying with these requirements, states must use limited transportation dollars efficiently. As requested, GAO addressed (1) the types of benefits and costs associated with these requirements for federal-aid highway projects; (2) the influence of these federal requirements on states' decisions to use nonfederal or federal funds for highway projects; and (3) the challenges associated with the federal requirements and strategies used or proposed to address the challenges. To complete this work, GAO reviewed 30 studies, surveyed DOTs in all states and the District of Columbia, and interviewed transportation officials and other stakeholders.

What GAO Found

Several of the studies GAO reviewed describe the benefits of environmental requirements for highway projects, such as better protection for wetlands, but none attempted to quantify these benefits. Some studies quantified certain types of environmental costs, such as costs for administering NEPA. In general, however, quantitative information on environmental benefits and costs is limited because states do not generally track such information. Several studies attempted to quantify the benefits and costs of the Davis-Bacon prevailing wage requirement; however, these studies did not focus on transportation projects specifically. Furthermore, while the studies reviewed did not identify the benefits of the DBE program, transportation officials identified some benefits of the program, such as providing greater opportunities for DBE firms. One study reviewed identified the benefits of the Buy America program, including protecting against unfair competition from foreign firms. The studies reviewed also identified, and in some cases quantified, the costs of the DBE and Buy America programs, including administrative costs and the use of higher priced iron and steel in projects.

Of the 51 state DOTs GAO surveyed, 39 reported that, in the past 10 years, federal requirements had influenced their decision to use nonfederal funds for highway projects that were eligible for federal aid. Thirty-three of these state DOTs reported that NEPA factored

into their decision to use nonfederal funds, while the other three requirements GAO reviewed were a factor only in a few states. State officials said that they use nonfederal funds for certain projects to avoid project delays or costs associated with the federal requirements or because of other factors, such as requirements imposed by a state legislature. A state's funding decision may depend on whether the state has requirements similar to these federal requirements. The decision may also take into consideration the availability of nonfederal and federal funds. For example, officials from one state said that they have limited nonfederal funds available, and as a result, like other states GAO interviewed, rely on the federal funds to finance their highway projects.

According to transportation officials and contractors, administrative tasks associated with the federal requirements pose challenges. For example, analyzing impacts and demonstrating compliance with NEPA requires extensive paperwork and documentation. State officials also said that coordinating with multiple government agencies on

environmental reviews is challenging, in part because these agencies may have competing interests. Furthermore, according to state DOTs, some provisions of the federal requirements may be outdated. For example, the \$2,500 regulatory cost threshold for compliance with the Buy America program for purchasing domestic steel and \$750,000 regulatory personal net worth ceiling of the DBE program have not been updated since 1983 and 1999, respectively. All of these challenges may cause delays and increase project costs. Some government agencies have implemented strategies to address these challenges and these strategies have had varied success in decreasing project costs and delays.

What GAO Recommends

The Department of Transportation should re-evaluate the Buy America threshold and the DBE personal net worth ceiling, and modify them, if necessary. The Department of Transportation provided technical comments on the report, but took no position on the recommendation.

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Privatizing Rest Stops Allows States to Serve Motorists and Increase Revenues by Ronald D. Utt, (Heritage Foundation, 214 Massachusetts Ave NE, Washington DC 20002-4999; ph 202.546.4400; <http://www.heritage.org/Research/SmartGrowth/wm2724.cfm>) (Dec 2009)

Highlights

- ❑ Private-sector operators of rest areas would pay rent to the state for the privilege of leasing the space.
- ❑ For example, Pennsylvania earns \$60 million a year from its commercialized rest areas, while Virginia plans to “save” \$12 million a year by shutting down 18 rest areas.

With many states facing budget deficits, rest stops on interstate highways--which require significant sums to maintain, but provide no revenue to the state--are on the chopping block. To save \$12 million a year, Virginia closed 18 of the state’s 42 rest areas. Georgia, Arizona, Vermont, Louisiana, New Hampshire, and Maine have also closed or will close some of their rest areas for the same reason. More states are likely to join in as state revenues continue to fall.

While these rest stop closures have caused negative controversy for state officials, there are a number of no-cost ways to keep them open. Some of the potential solutions could yield substantial revenues to the state transportation departments as costly liabilities are transformed into valuable assets.

The rest areas located on interstate highways built after 1956 are rather Spartan affairs, consisting of little more than a parking lot, restrooms, a picnic area, and perhaps some vending machines. The reason for the limited services is that existing roadside businesses were concerned about the diversion of traffic (and customers) onto the new interstates. To

protect their interests, a new federal law was enacted mandating that “the state will not permit automotive service stations or other commercial establishments for serving motor vehicle users to be constructed or located on the rights-of-way of the interstate system.”

Fifty-three years later, most of these protected businesses have disappeared, replaced by national chains, which benefit from this archaic protection at the expense of convenience and safety for motorists and truckers. The U.S. Department of Transportation (USDOT) justifies the continued prohibition by noting, “The absence of commercial services means motorists can stop without any pressure to make purchases.”

In contrast, the toll-financed, limited access highways built prior to the enactment of the federal highway program in 1956 had already commercialized their rest stops with gas stations and restaurants. When these existing highways were rolled into the interstate system after 1956, their areas were grandfathered and, thus, not subject to the prohibition. In this regard it should be noted that the recent contract between the Carlyle Group (a private equity firm in Washington, D.C.) and the state of Connecticut to takeover, rebuild, enhance, and manage 23 of the state’s rest stops involves areas that pre-date the federal prohibition and were already commercialized, albeit at a poor level of service under state management.

As a result, the difference between the pre- and post-1956 systems is striking. Anyone traveling on Interstate 95 knows firsthand the

dramatic difference between Virginia's public rest areas and the privatized ones in Maryland, Delaware, Pennsylvania, and New Jersey.

In all cases, the many consumer benefits are coupled with benefits to the states' taxpayers, because the private-sector concessionaires pay rent to the state for the privilege of leasing the space. In Pennsylvania, food concessionaires pay to construct their facilities and then transfer ownership of the buildings to the state in return for lower rent. Financially, the contrast is striking: Pennsylvania earns \$60 million a year from fuel sales alone, while Virginia plans to "save" \$12 million a year by shutting down 18 rest areas.

Although current federal law prohibits states with post-1956 interstates from privatizing/commercializing their rest areas, there are a number of remedies available to keep the rest areas open and/or convert them from tax users to revenue generators.

Amend the Law. One way around the prohibition is to amend the existing federal law to provide an exemption for a state or to strike the prohibition all together. In response to Virginia's rest stop problem, Congressman Frank Wolf (R-VA) introduced an amendment to allow for the privatization of the state's rest stops.

Wolf lost the vote in subcommittee. According to a Washington Post report, the fast-lobby "pressured members of the subcommittee to leave well enough alone so as not to kill the McDonald's and Wawa franchisees with strategic locations just off some of the exit ramps of Virginia's federal highway system."

Ignore the Law. With a legislative remedy blocked, at least for now, Virginia might simply ignore the prohibition and begin the process of commercialization without a formal federal approval.

Many states (with California being Exhibit A) repeatedly ignore federal rules they believe contrary to the state's interest, and the federal government often ignores the affront. Virginia ignored the USDOT's prohibition against single-occupant hybrid access to designated HOV lanes, and the USDOT remained silent. Significantly, President Obama has been an active party to the process of ignoring inconvenient federal laws, instructing Attorney General Eric Holder, for example, not to enforce federal laws against marijuana sales and use where such sales are permitted by state law. Although motorists and truckers do not have the trendy cachet of pot smokers, a precedent has been set, and setting a new one for rest stops should be on the President's agenda.

Redirect Federal Money. Alternatively, states might want to devote some of the money they receive from the "Federal Enhancement Program," to keep the rest stops open. The enhancement program is carved out of the federal highway trust fund and provides federal money that can be spent only on 12 eligible purposes, including tourist and welcome centers. States have mostly used this program for earmarks of questionable value, but there is no reason these substantial resources could not be shifted to rest stops.

During his successful campaign, Governor-elect Bob McDonnell of Virginia promised that he would reopen the rest stops within 90 days of taking office in January 2010. His transition staff is working on the issue and probably considering some or all of the above ideas, as well as some new ones. How he does this could serve as a model for other states suffering under the heavy hand of the federal government and its efforts to protect corporate privilege.

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Freight Rail Security: Actions Have Been Taken to Enhance Security, but the Federal Strategy Can Be Strengthened and Security Efforts Better Monitored (Government Accountability Office, 441 G St., NW, Washington, DC 20548; <http://www.gao.gov/new.items/d09243.pdf>; Cathleen Berrick at (202) 512-3404 or berrickc@gao.gov) (Apr 2009)

Highlights

- TSA's efforts have focused almost exclusively on rail shipments of certain highly toxic materials.
- TSA lacks a mechanism to monitor security actions and evaluate their effectiveness.

Why GAO Did This Study

An attack on the U.S. freight rail system could be catastrophic because rail cars carrying highly toxic materials often traverse densely populated urban areas. The Department of Homeland Security's (DHS) Transportation Security Administration (TSA) is the federal entity primarily responsible for securing freight rail. GAO was asked to assess the status of efforts to secure this system. This report discusses (1) stakeholder efforts to assess risks to the freight rail system and TSA's development of a risk-based security strategy; (2) actions stakeholders have taken to secure the system since 2001, TSA's efforts to monitor and assess their effectiveness, and any challenges to implementing future actions; and (3) the extent to which stakeholders have coordinated efforts. GAO reviewed documents, including TSA's freight rail strategic plan; conducted site visits to seven U.S. cities with significant rail operations involving hazardous materials; and interviewed federal and industry officials.

What GAO Found

Federal and industry stakeholders have completed a range of actions to assess risks to

freight rail since September 2001, and TSA has developed a security strategy; however, TSA's efforts have primarily focused on one threat, and its strategy does not fully address federal guidance or key characteristics of a successful national strategy. Specifically, TSA's efforts to assess vulnerabilities and potential consequences to freight rail have focused almost exclusively on rail shipments of certain highly toxic materials, in part, because of concerns about their security in transit and limited resources. However, other federal and industry assessments have identified additional potential security threats, including risks to critical infrastructure and cybersecurity. Although many stakeholders agreed with TSA's initial strategy, going forward TSA has agreed that including other identified threats in its freight rail security strategy is important, and reported that it is reconsidering its strategy to incorporate other threats. Additionally, in 2004, GAO reported that successful national strategies should identify performance measures with targets, among other elements. TSA's security strategy could be strengthened by including targets for three of its four performance measures and revising its approach for the other measure to ensure greater consistency in how performance results are quantified.

Federal and industry stakeholders have also taken a range of actions to secure freight rail, many of which have focused on securing certain toxic material rail shipments and have been implemented by industry voluntarily;

however, TSA lacks a mechanism to monitor security actions and evaluate their effectiveness, and new requirements could pose challenges for future security efforts. GAO's *Standards for Internal Control in the Federal Government* calls for controls to be designed to ensure ongoing monitoring. While the freight rail industry has taken actions to better secure shipments and key infrastructure, TSA has limited ability to assess the impacts of these actions because it lacks a mechanism to systematically track them and evaluate their effectiveness. Having such information could strengthen TSA's efforts to efficiently target its resources to where actions have not been effective. New, mandatory security planning and procedural requirements will also necessitate additional federal and industry efforts and resources, and may pose some implementation challenges for both federal and industry stakeholders.

Federal and industry stakeholders have also taken a number of steps to coordinate their freight rail security efforts; however, federal coordination can be enhanced by more fully leveraging the resources of all relevant federal agencies. GAO previously identified a number of leading practices for effective coordination that could help TSA strengthen coordination with federal and private sector stakeholders.

What GAO Recommends

Among other things, GAO recommends that TSA reflect all security threats in strategy, strengthen its performance measures, better assess and track actions being taken, and more closely work with some federal stakeholders. DHS generally concurs with GAO's recommendations and has initiated action on some; however, these actions will not fully address all of the recommendations.

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The High Cost of High-Speed Rail by Randal O'Toole (Texas Public Policy Foundation; 900 Congress Ave., Suite 400, Austin, Texas 78701; phone (512) 472-2700; <http://www.insideronline.org/summary.cfm?id=10825>) (Aug 2009)

Highlights

- ❑ High-speed rail will be extremely costly and will add little to American mobility or environmental quality.
- ❑ The main patrons of high-speed trains will be the wealthy.
- ❑ High-speed trains are likely to do more harm to the environment than good.

In February 2009, Congress dedicated \$8 billion of stimulus funds to high-speed rail projects. In April 2009, President Obama released his high-speed rail “vision” for America, which includes 8,500 miles that the Federal Railroad Administration (FRA) had identified as potential high-speed rail routes in 2001. In June, the FRA announced its criteria for states to apply for high-speed rail grants out of the \$8 billion in stimulus funds.

Yet the FRA has no estimates of how much high-speed rail will ultimately cost, who will ride it, who will pay for it, and whether the benefits can justify the costs. A realistic review shows that high-speed rail will be extremely costly and will add little to American mobility or environmental quality.

The best available data indicate that the FRA plan will cost about \$90 billion, or roughly one-fifth the inflation-adjusted cost of the Interstate Highway System. This plan will provide trains with average speeds of 140-150 miles per hour (mph) in California, 75-85 mph in Florida, and moderate-speed trains averaging 55-75 mph in Texas and 30 other states (though the actual speed for Texas was left ambiguous).

The average American will ride these trains less than 60 miles per year, or about 1/70th as much as the average American travels on interstate freeways. In fact, most of the taxpayers who pay for high-speed trains will rarely or never use them. Because of a premium fare structure and downtown orientation, the main patrons of high-speed trains will be the wealthy and downtown workers, such as bankers, lawyers, and government officials, whose employers pay the fare.

A true high-speed rail system, with average speeds of 140-150 mph connecting major cities in 33 states, would cost well over \$500 billion. Meeting political demands to close gaps in the system could bring the cost close to \$1 trillion. At twice the cost of the Interstate Highway System, such a true high-speed rail system would provide less than 1/10th the mobility offered by the interstates.

These costs include only the projected capital costs. States that decide to build moderate- or high-speed rail may be responsible for cost overruns, operating losses, and the costs of replacing and rehabilitating equipment about every 30 years.

Upgrading the 640 miles of Texas tracks in the FRA plan to run trains at 110 mph would cost taxpayers more than \$2.2 billion. Adding a leg between Dallas and Houston that the FRA failed to include in its plan would increase the cost to \$3.1 billion, or more than \$130 for every Texas resident. Subsidizing passenger trains over those routes will cost at least \$70 million per year. Yet the average

Texan will take a round trip on such trains only once every 25 years.

Far from being an environmental savior, high- and moderate-speed trains are likely to do more harm to the environment than good. In intercity travel, automobiles are already as energy-efficient as Amtrak, and the energy efficiencies of both autos and airliners are growing faster than trains. The energy cost of constructing new high-speed rail lines will dwarf any operational savings. As the state of Florida concluded in 2005, “the environmentally preferred alternative is the No Build Alternative.”

Adding insult to injury, the administration is likely to require states that accept high-speed rail funds to regulate

property rights in a futile effort to discourage driving and promote rail travel. These regulations will deny rural landowners the right to develop their land while they make urban housing unaffordable and disrupt neighborhoods through the construction of high-density housing.

For all of these reasons—high costs, tiny benefits, and interference with property rights—Texas should not attempt to provide high-speed rail service. Instead, it should use its share of the \$8 billion stimulus funds solely for incremental upgrades, such as safer grade crossings and signaling systems, that do not obligate state taxpayers to pay future operations and maintenance costs.

TRANSPORTATION RESEARCH DIGEST

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Design and Evaluation of Effective Crosswalk Illumination by John D. Bullough, Xin Zhang, Nicholas P. Skinner & Mark S. Rea, Lighting Research Center, Rensselaer Polytechnic Institute, 21 Union Street, Troy, NY 12180 USA (New Jersey Department of Transportation, P.O. Box 600, Trenton, NJ 08625; <http://www.utrc2.org/research/assets/152/FHWA-NJ-2009-0031.pdf>) (Mar 2009)

Highlights

- The analyses in the present report suggest a more general method that can be used by NJDOT in evaluating the visibility produced by pedestrian and roadway lighting systems.

The bollard-based lighting solution evaluated and demonstrated in the present study proved to be a feasible solution toward improving pedestrian visibility, and also for reducing operating and electricity costs. Luminaires rated for outdoor use and with light distributions appropriate for the application exist. Undoubtedly, the optimization of luminaire light distributions could be furthered in order to provide higher uniformity of vertical illuminance along the crosswalk and, as described in the field demonstration section of this report, glare control can be improved through use of louvers or baffles to limit light directed toward oncoming drivers, while maintaining light toward the crosswalk itself.

Although there is a benefit to the use of bollards as architectural elements to help direct pedestrian traffic to crosswalks, especially for mid-block applications, and for delineating the location of crosswalks to drivers during both daytime and nighttime, the use of bollard luminaires is not always going to be practical in certain locations. The results of the visibility and economic evaluations of the overhead lighting configurations conducted for the present study show that overhead lighting, offset ahead of the crosswalk location by about

15 ft, will result in improved visibility of pedestrians, at least in the lane of traffic occupied by oncoming traffic. Unless a luminaire is similarly located across the roadway, however, pedestrians can undergo a transition from positive to negative contrast (or vice versa) when crossing the roadway under such systems. The bollard configuration can be adapted to pole-mounted applications, as well.

As mentioned above, the distribution of the specific luminaires used in the field demonstration was not optimized for illuminating crosswalks across four-lane roadways, resulting in reduced vertical illuminances lower than the 20 lux value that has been recommended in previous studies. Lower vertical illuminances on pedestrians may not be a problem because the bollard luminaires, unlike overhead lighting do not provide substantial levels of horizontal illumination on the roadway outside the crosswalk, and therefore there is less vertical illuminance on pedestrians required to ensure that they will be seen in positive contrast.

The use of fluorescent lighting technology for roadway applications is not common, although roadway lighting systems using this technology have been commercially available for many years. Equipment for starting and operating lamps at the proper current is operable for cold-weather conditions, and enclosed luminaires will achieve reasonably high internal temperatures even when exterior temperatures are low.

Luminaires using high intensity discharge lamps tend to be much brighter than fluorescent luminaires; when used in pole-mounted systems at mounting heights greater than 20 ft, glare is less of an issue, but for a bollard luminaire, the use of fluorescent lamps has a strong utility when glare reduction is considered. Presently, the cost of LED components and systems do not make them feasible candidates for roadway lighting at pedestrian crosswalks, although both the technology and its price points are evolving rapidly.

The use of a "signal" function to help draw attention to pedestrians waiting to use the crosswalk can be incorporated into the bollard-based system relatively easily. For example, light output of the system could be dimmed by operating only one lamp in a multiple-lamp ballast, or by operating them at reduced current using electronic ballasts, and either

synchronized to the pedestrian signal timing, or timed to reach full light output if the pedestrian signal button is pressed. Operating the luminaires in such a way that they are off when no pedestrians are present (or when nobody has pressed the signal button) is not recommended because a reduced light level will still provide improved visibility over no lighting at all.

Finally, the analyses in the present report suggest a more general method that can be used by NJDOT in evaluating the visibility produced by pedestrian and roadway lighting systems. The RVP model is a validated system for quantifying the impact of lighting conditions on visual responses and can be used as a procedure for assessing novel approaches to lighting. Such a procedure can be especially useful in justifying the use of new approaches not considered in standardized documentation for lighting.

TRANSPORTATION RESEARCH DIGEST

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Evaluation of the Work Zone Safety and Mobility Rule by Kenneth R. Agent and Jerry G. Pigman, Kentucky Transportation Center, College of Engineering, University of Kentucky, Lexington, Kentucky 40506-0281 (Kentucky Transportation Cabinet, 200 Mero Street, Frankfort, Kentucky 40622) (Mar 2009)

Highlights

- Recommendations for how to comply with federal regulations are outlined.

The Work Zone Safety and Mobility Rule (Rule) was published in the Federal Register in September 2004 indicating that all state and local governments receiving Federal-aid funding were required to comply with provisions of the Rule no later than October 2007. Kentucky received an extension to October 2008. The objectives of this study were to review the requirements of the Work Zone Safety and Mobility Rule and provide recommendations for implementation of the Rule to ensure a consistent approach for designing and managing the impacts of work zones. This report documents results from: a) a review of literature and Kentucky's policy, b) an analysis of work zone crashes in Kentucky, and c) an evaluation of the safety and training aspects of the Rule. The emphasis was on the safety aspect of the Rule.

The requirements of this Rule relating to work zone safety were reviewed along with the related procedures adopted by other states. Crash data occurring in work zones in Kentucky for the past several years were summarized. A description of the training developed to meet the requirements of the Rule is described. Recommendations were made.

Recommendations

The following recommendations are made to consider in the implementation the

Kentucky Transportation Cabinet's *A Policy and Procedures for the Safety and Mobility of Traffic through Work Zones*.

1. Designate a District Work Zone Safety Coordinator (DWZSC) for each of Kentucky's 12 highway districts. For maximum effectiveness, this position should be separate from the district safety coordinator position.

2. Prepare an annual summary (by district) from the CRASH database of all reported construction and maintenance crashes (coded on the police report as an environmental factor). This would include a summary by county and route. The crash reports for the county and route locations having the highest number of crashes should be reviewed to determine if any patterns can be found. Combine the results from each district to develop a statewide summary. The analysis could be completed by each DWZSC with the results given to the Statewide Work Zone Review Committee (SWZRC) or a statewide analysis could be prepared with the results provided to each district. The SWZRC should include the statewide summary as part of their annual report.

3. The SWZRC should conduct an annual review of all reported fatal crashes in construction/maintenance zones using information about each fatal crash obtained from the DWZSC. The results would be included in their annual report.

4. Each year the DWZSC should select one significant project and one maintenance project in their district for a review by a group

of district personnel. The analysis should involve visiting the project and reviewing the traffic control and its adherence to applicable traffic control plans. A review of any crashes within the project should also be included. The review and analyzes will result in a report sent to the SWZRC. Recommendations, using information obtained from each district, should be included in the annual construction evaluation report from the SWZRC using both the CRASH analysis and project monitoring data as input.

5. The training for the work zone supervisor (WZS) should include a section emphasizing the need to coordinate with the appropriate police agencies so that reports for crashes occurring in work zones are obtained as soon as they are available. The training should also include the necessity to document the traffic control in effect when crashes occur. Each WZS and DWZSC should be provided with a camera to document the traffic control in place when a crash occurs.

6. For significant projects, the DWZSC should document the crash history for an approximate three-year period prior to the start of construction. A procedure to quickly obtain copies of crash reports occurring in the work zone should be established in the pre-construction meeting. This involves coordination with the responsible police agencies. Each crash report should be reviewed

with any subsequent changes made in traffic control documented. At the end of the project, the DWZSC should summarize crash data during construction to compare to the before crash history. Recommendations for changes in future work should be made and sent to the SWZRC.

7. Crash data should be collected in work zones not defined as a significant project. Also, a list of crashes occurring during maintenance projects should be obtained from maintenance engineers.

8. The SWZRC should prepare an annual report which contains: a) the statewide CRASH summary and review of fatal crashes, b) the evaluation of the sample of projects from each district (including the site visits), c) before and during crash data at significant projects, and d) a summary of crash data both at projects not defined as significant and at maintenance projects. This information will be obtained using the summary of the information obtained from each DWZSC.

9. An annual meeting of the SWZRC and the DWZSC from each district should be conducted to discuss results from the analysis and evaluations of the previous year.

10. Standard language should be provided in contract proposals to allow liquidated damages if contactors do not respond to identified traffic control problems in a specified time.

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Implementation Project: Strengthening of a Bridge near Hondo, Texas using Post-Installed Shear Connectors by Gunup Kwon, Michael D. Engelhardt, Richard E. Klin, Center for Transportation Research, University of Texas at Austin, 3208 Red River, Suite 200, Austin, TX 78705-2650 (Texas Department of Transportation, Research and Technology Implementation Office, P.O. Box 5080, Austin, TX 78763-5080; http://www.utexas.edu/research/ctr/pdf_reports/5_4124_01_1.pdf) (Mar 2009)

Highlights

- The addition of post-installed shear connectors can significantly increase the strength of existing non-composite bridge girders.

Overall, the results of this study indicate that the addition of post-installed shear connectors can significantly increase the strength of existing non-composite bridge girders. By using partial composite design, the addition of a relatively small number of post-installed shear connectors can increase the flexural capacity of an existing girder in positive moment regions by 40 to 50%. The use of post-installed shear connectors can therefore provide an effective means for strengthening existing non-composite bridges. Some specific observations and conclusions from this implementation project are as follows:

- A complete design process to strengthen the Hondo Bridge using post-installed shear connectors was developed in this study, and can be used as a model for future strengthening projects. This design process resulted in a recommendation to install 28 shear connectors per girder for the DBLNB and HTFGB connectors, and 52 shear connectors per girder for the HASAA connector. A larger number of HASAA connectors were needed due to the lower fatigue strength of this connector.

Shear connectors were installed at 12-in. spacing near the ends of each girder. No shear connectors were installed in the center portion of the girders. Locating the shear connectors near the beam ends enhances the ductility of the retrofitted girders.

- A load rating was conducted for the Hondo Bridge prior to retrofit, showing an HS10.6 inventory level rating and an HS17.6 operating level rating. With the addition of the post-installed shear connectors, the load rating for the bridge increased to HS17.4 inventory level and HS29.1 operating level. Thus, both the inventory level and operating level load ratings increased 65-percent as a result of the installation of post-installed shear connectors.
- The effect of fatigue on the required number of shear connectors was evaluated in this case study. The results of this evaluation showed that fatigue did not control the required number of connectors for the DBLNB and HTFGB connectors. For these cases, the required number of connectors was controlled by static strength requirements, and the 28 post-installed shear connectors per girder, based on partial composite design, were adequate to achieve the load-rating increase noted above.

- In the case of the HASAA connectors, fatigue controlled the required number of connectors. This is because the fatigue life of the HASAA connector is less than that for the DBLNB and HTFGB connectors, although it is still substantially better than for conventional welded studs. In the case of the HASAA connector, satisfying fatigue design requirements, 52 connectors were needed, as compared to 28 based on static strength requirements. Note that for conventional welded studs, approximately 120 shear studs per girder would be needed to satisfy AASHTO fatigue requirements. Also, as described in Chapter 3, finite element analysis indicated that 28 HASAA connectors per girder would actually have been satisfactory for fatigue. The increase from 28 to 52 was needed as a result of using conservative hand calculation methods to compute the stress range in the connectors.
- Load tests were conducted on the Hondo Bridge before and after the retrofit. Composite behavior after the retrofit was verified by measuring deflections and strain profiles in steel beam sections. The load tests showed that significant composite action was developed in the retrofitted bridge girders, as expected.
- A finite element model was developed and parametric studies were conducted to investigate the effects of steel beam depth, span length, and shear connection ratio on the overall system performance of the strengthened partially composite beams. The analysis results showed that an increase in beam depth and span length resulted in reduced deformation capacity of composite beams. Composite beams with a high shear-connection ratio showed better deformation capacity than composite beams with a low shear-connection ratio. All of the composite beams with a shear connection ratio of at least 30% showed a global ductility factor of at least two. Based on this analysis, a minimum shear connection ratio of 30% is recommended. Based on the analysis results, it was also shown that the strength and stiffness of composite beams retrofitted with post-installed shear connectors can be accurately calculated using current AASHTO and AISC design equations. The parametric study also showed that the gap between the oversized holes in the steel beam flange and the shear connector does not significantly affect the strength of partially composite beams constructed with post-installed shear connectors. Consequently, oversize holes (hole diameter is 1/8-inch greater than fastener diameter) can be used to facilitate construction. Nonetheless, it is beneficial to eliminate such gaps if possible, because doing so increases stiffness and ductility of the retrofitted girder.
- The actual installation of the post-installed shear connectors on the Hondo Bridge proved considerably more difficult than anticipated prior to construction and based on the connector installation experiences in Project 0-4124. Problems encountered during the construction are described in Chapter 3, along with suggestions for mitigating these problems in future installations.

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The Impacts of Tolling on Low-income Persons in the Puget Sound Region by Robert Plotnick, Jennifer Romich, Jennifer Thacker, 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/721.1.pdf>; Proj Mgr: Kathy Lindquist, 360-705-7976) (Apr 2009)

Highlights

- A smaller percentage of the poor than the non-poor are likely to be affected by tolling.
- Tolls are likely to have a significant impact on those poor who are affected.

Based on the background knowledge from the literature review and the capacity of the best available data, the researchers conducted original empirical research. The researchers created a new geographic specific route-based analysis to determine the distribution of current highway use and used these findings to project impacts of hypothetical tolling regimes.

A smaller percentage of the poor than the non-poor are likely to be affected by tolling in the Puget Sound region. The poor are less likely than the non-poor to commute in a personal vehicle and more likely to commute using public transportation or other modes that would not be subject to tolls. Among commuters, the poor are less likely to use highway routes that may be tolled.

The researchers use these findings to project the financial impact of two hypothetical tolling regimes. The first imposes a one-way toll of \$2 on 12 major highway segments in King County. Across all households - whether or not they commute on tolled segments -- the average annual cost of such a plan for households at the poverty line would be \$772

or 4.4 percent of income and, for households with the median income, \$1,266 or 1.8 percent of income. For households that drive on one or more tolled segments, the average cost is much higher—about \$2,600 per year for both poor and non-poor households. Such tolls would absorb 15.2 percent of a poor household's income, or about four times the rate for a non-poor household. Non-users, of course, would pay nothing. Devoting 15 percent of income to tolls would force large reductions in other types of expenditures and, thus, substantially reduce the economic well-being of poor households whose workers commute in private vehicles.

The second regime imposes a \$2 one-way toll only on the SR 520 bridge. The small number of poor households that use the bridge would pay \$960 per year, or 5.5 percent of income. The corresponding small set of non-poor households would also pay \$960, which would equal 1.4 percent of their income. The costs of tolls would certainly reduce the economic well-being of poor users of the SR 520 bridge.

The study has several important limitations. Estimates based on the HAS are imprecise because its sample of poor households is small, and the researchers could not estimate possible time savings due to tolls. The study's projections assume a toll that does not vary by time or day nor provide a non-tolled option. The level and distribution of the

costs of congestion tolls or HOT lane tolls with adjacent free lanes would surely differ. The study's estimates are based on current commuting patterns and do not take into account tolls' effects on travel mode, choice of route, or other relevant behaviors. These limitations call for caution in interpreting the findings and drawing policy conclusions from them.

Future Research

To better estimate tolls' impacts on low-income populations in Puget Sound, future

research needs to collect more or slightly different information from existing ongoing surveys. Emphasis should be placed on over sampling poor households and obtaining high quality data on income and home and work locations.

In addition, conducting a randomized field experiment could better identify how regional travel patterns are likely to change in response to tolls. Such an experiment would be a major undertaking with the potential to significantly advance knowledge about responses to tolling regimes.