TRANSPORTATION RESEARCH DIGEST

January 2010

ARIZONA TRANSPORTATION INSTITUTE

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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.

Code	Topic	Code	Topic
ADM	Administration	PLAN	Planning
AIRP	Airports	PRIV	Privatization
AVIA	Aviation	RAIL	Railroads
BIKE	Bicycles	RDSD	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

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Thank you.

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Driving the Economy: Automotive Travel, Economic Growth, and the Risks of Global Warming Regulations by Randall J. Pozdena (Cascade Policy Institute, 4850 SW Scholls Ferry Road, Suite 103, Portland, Oregon 97225; http://www.cascadepolicy.org/pdf/VMT%20102109.pdf; phone: 503.242.0900) (Nov 2009)

Highlights

- VMT is a large and statistically significant driver of GDP.
- Policies aimed at reducing VMT will reduce GDP.
- Technologies aimed at reducing emissions/VMT will be less harmful.

This study examines the role that highway vehicle miles traveled (VMT) plays in supporting national economic activity. This study is important because highway travel generally, and light vehicle travel specifically, represent a significant share of total energy consumption and fossil fuel carbon emissions.

Numerous federal and state initiatives are in place or under consideration with the aim of reducing VMT. The focus on vehicle travel is natural considering the important role that transportation plays in the use of fossil fuels. However, in designing programs to manage carbon emissions, it is important to understand the effects of these programs and the consequences for the economy if they are used to achieve a smaller carbon footprint via VMT reductions.

There is an intimate relationship between VMT and GDP:

- Energy use and GDP growth trends are nearly indistinguishable over time.
- On average, there is a near one-for-one relationship between economic growth and growth in energy use across a sample of 177 countries.
- Growth in vehicle miles traveled and GDP also display highly similar trends over time.
- Energy use per dollar of real GDP and per vehicle mile traveled show steadily declining trends over long periods, even when no fleet efficiency regulation was in place.

The econometrics literature regarding energy and the economy reveals a strong tendency for energy to "cause" GDP growth. The VMT-economy causality investigation finds that, indeed, VMT is a large and statistically significant driver of GDP. It finds also that, historically at least, the price of energy has not been an important driver of innovation in vehicle efficiency. If fuel efficiency could be improved, there would be positive economic effects, but limited, long-run effects on VMT.

Although long-run econometric predictions have large error ranges, the results suggest that rather than employing broad, tax-based strategies in transportation (such as cap-and-trade or carbon taxes), it may be better to find ways (if they exist) to advance fuel-efficiency technology. These efficiency improvements, however, can be expected to yield less than one-for-one reductions in VMT and energy use due to the rebound effect.

With these and other results in hand, the study reviews a wide range of candidate policies for using VMT management as a channel for climate change redress. The author

concludes that the evidence does not support use of non-economic manipulation of energy prices, technology subsidies or quantity regulation to improve highway VMT's energy footprint. Rather, the author recommends the following:

- Implementation of highway congestion pricing. This policy generates economic benefits by eliminating wasted travel time while, incidentally, reducing a certain amount of travel. Thus, it is uniquely, perhaps, a policy that will aid today's economy while contributing to reductions in atmospheric carbon loads even without changes in technology.
- A cost-based, revenue-neutral carbon tax can be justified theoretically if its proper level is known, set properly and revenues are returned (as, say, offsets of other taxes). For reasons explained in the report, such a tax may accelerate the penetration of fuel-efficiency technology, but not particularly rapidly.
- Subsidy of basic research may have potential as a productive avenue of policy. It is important, however, that subsidies of energy- or carbon-sparing technologies not be used for adoption of non-economic alternatives.
- Replacing "old" capital with new, but non-economic, energy- or carbon-efficient technology may actually aggravate adverse economic impacts and atmospheric accumulation of carbon dioxide.
- The intimacy and strength of the causal relationship between vehicle activity and the economy is such that we should approach direct, regulatory interventions with great caution. The author includes in this list regulating land use to achieve VMT outcomes, rationing schemes, and limits on vehicle use (such as alternate-day driving rules).

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Measuring Tire-Pavement Noise at the Source, *NCHRP Report 630* by Paul R. Donavan & Dana M. Lodico, Illingworth & Rodkin, Inc., Petaluma, CA (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_630.pdf) (2009)

Highlights

- The on-board sound intensity (OBSI) method was found to be the preferred approach for developing an at-the-source tire-pavement noise test procedure.

Based on the research work completed in this project, the on-board sound intensity (OBSI) method was found to be the preferred approach for developing an at-the-source tire-pavement noise test procedure. The close proximity (CPX) approach was not desired due to spectral distortion observed relative to the passby data, a slightly lower ability to correlate with overall passby levels, practical concerns in the use of a CPX trailer or "facility," and the expense of acquiring and maintaining a CPX trailer. The two methods were found, however, to correlate well with each other on an overall level basis and one could be used to reliably estimate the other, particularly after some initial calibration.

Site-to-site variation was found to be a significant issue affecting the correlation between OBSI and passby measurements, as observed in sound propagation measurements. In using passby data to quantify pavement noise performance, more strict requirements on measurement sites need to be considered for direct comparison of data from different sites. Simultaneous OBSI and controlled passby (CPB) measurements were found to be an effective means of identifying and quantifying site biases.

OBSI data can be used to predict statistical passby (SPB) levels for light vehicles and heavy trucks using offsets applied to the OBSI levels. This yields predictions for an "average" site as defined by the sites tested in this research. Use of the offsets defined in this work should provide a reasonable estimate of passby levels based on measured OBSI levels. For specific sites of varying properties, greater variance could be expected between predicted and measured levels, however, a better defined "average" site would probably not help to reduce this uncertainty.

Consistent with the REMELs database, heavy trucks were found to be about 9 dB louder than light vehicles. Unexpectedly, the SPB levels for trucks could be almost as accurately predicted from OBSI data as it could for light vehicles. The analysis indicated that at lower speeds (i.e., 50 to 55 mph) some increase in noise level, which is not attributable to tire-pavement noise alone, occurs with trucks likely due to engine/exhaust noise. However, within a standard deviation of 1 dB, truck SPB levels could be predicted even for 50 mph. Also unexpected was the finding that the more aggressive "winter" Dunlop tire did not provide any better correlation to the truck passby levels than the Standard Reference Test Tire (SRTT). This leads to the conclusion that changes in passby noise levels with pavement for heavy trucks can be fairly well predicted on the basis of tire-pavement levels alone at least for speeds of 50 mph and above. However, it is unclear

why the levels are typically almost 10 dB higher for trucks than light vehicles.

Within the uncertainty of site-to-site variation encountered for non-porous pavements (Test Sites 1 through 11), the porous Test Site 12 did not display any unique behavior. The spectrum shape of the OBSI levels was unique relative to the other sites and displayed the same shape as the porous pavement Test Site S4. As a result, the Test Site 12 pavement would be expected to have similar sound-absorbing properties as those documented for S4. However, much of the difference between this pavement and the others appears to be accounted for in the OBSI data. For Test Site 12, actual propagation over the porous pavement was quite limited; larger effects may be encountered for propagation over multiple lanes of sound-absorbing pavement.

In regard to the test tire, no overwhelming experimental evidence was found to favor one tire over the other. The Dunlop tire produced levels closer to those measured for the light vehicle statistical passby events, however, both tires tracked equally well with the differences seen in the SPB data for different pavements. Both tires displayed similar sensitivity to test variables in most cases. With the lack of a clear difference based on acoustic performance, the selection of the test tire can be made on the basis of other, non-noise related issues.

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Vaporizing the Gas Tax Myth by Jack Finn, National Director of Toll Services for HNTB Corporation (Planetizen, 5657 Wilshire Blvd., Suite 290, Los Angeles, CA 90036; Email editor@planetizen.com; phone: 877-260-7526; http://www.planetizen.com/node/42392) (Jan 6, 2010)

Highlights

- Congestion costs every traveler in the U.S. $750 a year.
- We need to invest at least $225 billion annually for the next 50 years to repair and upgrade the system.
- Gas taxes don't yield enough to meet these needs.
- We must move away from the gas tax to solutions that actually charge people for the roads they use.

The United States must move away from the gas tax to solutions that charge people for the roads they use, including a VMT fee, congestion pricing for peak hours and toll roads. Such efforts will encourage Americans to be less dependent on oil, reduce congestion, take public transit and properly invest in infrastructure.

Americans hate the gasoline tax about as much as they love their cars.

At the federal level, money from a gas tax was first placed into the Highway Trust Fund in 1956 as the country embarked on President Dwight Eisenhower's grand vision of establishing a network of interstate highways to spur commerce and aid in the country's defense.

Now, more than 50 years later, Eisenhower's long-ago realized vision is reaching the end of its useful lifespan, and the gas tax itself is running on empty.

This is unwelcome news to the average American driver, already suffering through the current economic downturn and the painful $4 per gallon gas that preceded it.

For years we've comforted ourselves with the notion that filling up at the pump pays for our roads in full. This is nothing more than a myth, a misperception that must end. In fact:

- There is no such thing as a free road. Anyone who has paid off a mortgage knows there are always costs of home ownership. Renovations, expansions and simple upkeep — while necessary — can be expensive. Simply paying off the original financing on a transportation project doesn't mean it's paid for either.
- Roads don't pay for themselves. Research from the Texas Department of Transportation has compared how much gasoline is consumed on a roadway with how much gas tax that generates, revealing that no road completely pays for itself over a 40-year lifespan.
- We've run up a huge transportation tab. Crumbling roads, rusting bridges and congestion are all signs we've deferred too much maintenance. According to a national commission that studied our surface transportation needs, we need to invest at least $225 billion annually for the next 50 years to repair and upgrade the system. The longer we wait the more expensive it becomes.
- The gas tax isn't what it used to be. The federal gas tax, now set at 18.4 cents

per gallon, was last increased in 1993. A combination of inflation, changing driving habits — due in part to higher gas prices — and better fuel economy of our cars has robbed it of much of its purchasing power. In fact, the trust fund is broke, needing infusions from the general treasury totaling more than $15 billion in the last year alone.

The way we fund our roads is at odds with almost every other public policy America has adopted. While proposed climate change legislation, green energy initiatives and even our foreign policy demand that we move away from a dependence on oil, we pay for our transportation system almost entirely by using more of it.

In the short-term, we need to consider an increase in the gas tax. It’s a bitter pill to swallow, but it's the only way we can ease the congestion we face. At last count, that congestion costs every traveler in the U.S. $750 a year. A gas tax increase between 5 cents and 8 cents each year during the next five years will cost average Americans only $10 to $20 each month per car.

In Britain and much of Europe the gas tax is nearly $4 per gallon, 20 times the federal tax in the U.S.

In the long-term, we must move away from the gas tax to solutions that actually charge people for the roads they use, including a vehicle miles traveled user fee, congestion pricing for peak hours and more toll roads. We’re willing to pay for actual use of other utilities — like electricity, water and natural gas — why not our roads?

Such efforts will encourage Americans to be less dependent on oil, reduce congestion, encourage use of public transit and properly invest in infrastructure.

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Chairman Oberstar's Transportation Plan: A Costly Exercise in Social Engineering by Ronald D. Utt, (Heritage Foundation, 214 Massachusetts Ave NE, Washington DC 20002-4999; ph 202.546.4400; http://www.heritage.org/Research/SmartGrowth/bg2348.cfm) (Dec 2009)

Highlights

- Congress has demonstrated more interest in spending money on influential constituencies than in relieving congestion and promoting cost-effective mobility.
- It would be better to end the federal highway program and turn it and the associated federal fuel tax revenues back to the states.

In June 2009, Representative James Oberstar (D-MN), chairman of the House Committee on Transportation and Infrastructure, introduced the Surface Transportation Authorization Act (STAA), a 775-page bill to reauthorize federal highway and transit programs for another six years. However, STAA would also dramatically change federal transportation policy by:

- Shifting resources from cars to trolleys and buses;
- Requiring a huge tax increase to fund these new commitments;
- Centralizing transportation decisions in Washington;
- Requiring a substantial increase in the numbers of state, local, and federal government employees; and
- Discouraging the private sector from investing in surface transportation projects.

SAFETEA-LU,2 the previous surface transportation reauthorization, expired on September 30, 2009, but has been temporarily extended until a new bill is signed into law. Although the Obama Administration has not objected to the provisions of STAA, it has requested that SAFETEA-LU be extended for 18 months to allow the President and the Senate time to develop and market their own transportation plan.

Other reasons that the President and the Senate are seeking an 18-month extension include:

- The legislative congestion caused by ongoing debates on health care, cap-and-trade legislation, and Afghanistan;
- The President's need for more time to develop his new "livability" program; and
- The hope that Congress will be more amenable to raising the federal fuel tax after the 2010 mid-term elections.

Fiscal conservatives and proponents of an improved transportation program should support the President's request for an 18-month extension, both because the delay would give them opportunities to expose the massive flaws in STAA and because the 2010 elections might produce a more responsible Congress that would write a better bill.

A common goal of STAA and the Senate's current version of the Clean Energy Jobs and American Power Act is to shift substantial numbers of passengers from cars to public transit and nonmotorized forms of transportation. These bills attempt to achieve this goal by raising existing taxes, imposing new taxes, and diverting the increased federal

revenues from roads to transit and bicycle paths. These bills would also create new federal regulations that would further discourage automobile use and crowd existing and new residential development into higher density communities, which would be more compatible with the more primitive forms of mobility common to America in the early years of the 20th century.

A major aim of this proposed legislation is to reduce greenhouse gas emissions, reinforced by the mistaken belief that -- despite all of the evidence to the contrary -- this can be accomplished by rearranging existing living and travel patterns. Given the evidence on fuel efficiency and greenhouse gas emissions from the different modes of travel, none of these bills would significantly help the nation or the environment. Instead, in the process of failing, these bills would impose great costs and inconveniences on American citizens and businesses. For this reason, these bills should be withdrawn from consideration or substantially modified so that they would actually benefit the nation.

In the past several highway reauthorization bills, Congress has demonstrated more interest in spending money on influential constituencies than in relieving congestion and promoting cost-effective mobility. STAA combines this predilection to spend with the goal of substantially altering lifestyles through regulations, subsidies, and penalties to crowd development, create higher population densities, and compel people to use public transit. As STAA now stands, it would be better to end the federal highway program and turn it and the associated federal fuel tax revenues back to the states.

In the meantime, proponents of an improved transportation program should support the President's request for an 18-month extension, both because the delay would give them opportunities to expose the massive flaws in STAA and because the 2010 elections might produce a more responsible Congress that would write a better bill.

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The Myth of the Compact City by Randal O'Toole (Cato Institute, 1000 Massachusetts Avenue, N.W., Washington D.C. 20001-5403; http://www.cato.org/pubs/pas/pa653.pdf; ph 202- 842-0200) (November 18, 2009)

Highlights

- Trying to force more compact cities as a way to reduce carbon emissions is a bad strategy.
- Charging for carbon emissions would be a more effective policy.

Proponents of compact development argue that rebuilding American urban areas to higher densities is vital for reducing greenhouse gas emissions. Compact city policies call for reducing driving by housing a higher percentage of people in multi-family and mixed-use developments, reducing the average lot sizes of single-family homes, redesigning streets and neighborhoods to be more pedestrian friendly, concentrating jobs in selected areas, and spending more on mass transit and less on highways.

The Obama administration has endorsed these policies. Secretary of Transportation Ray LaHood and Secretary of Housing and Urban Development Shaun Donovan have agreed to require metropolitan areas to adopt compact-development policies or risk losing federal transportation and housing funds. LaHood has admitted that the goal of this program is to "coerce people out of their cars."

As such, compact-development policies represent a huge intrusion on private property rights, personal freedom, and mobility. They are also fraught with risks. Urban planners and economists are far from unanimous about whether such policies will reduce greenhouse gas emissions. Some even raise the possibility that compact city policies could increase emissions by increasing roadway congestion.

Such reductions are insignificant compared with the huge costs that compact development would impose on the nation. These costs include reduced worker productivity, less affordable housing, increased traffic congestion, higher taxes or reduced urban services, and higher consumer costs.

Compact development is an indirect and risky way of reducing greenhouse gas emissions. It depends on people responding to compact cities in the ways that planners hope; on the assumption that reduced greenhouse gas emissions from reduced driving will not be offset by increased emissions from more driving in stop-and-go traffic; and on planners' faith that the costs of unintended (and intended) consequences such as unaffordable housing, congestion, and reduced worker productivities will not be greater than the benefits.

Those who are skeptical of the need to reduce carbon dioxide emissions should naturally reject compact-city schemes as an unnecessary and expensive imposition on personal freedom and mobility. Those who support policies to reduce carbon dioxide emissions should also reject compact-development programs as risky, cost-ineffective ideas that will divert resources and attention away from genuine emission-reduction programs.

One of the most effective ways of reducing carbon emissions is simply to price them using a revenue-neutral carbon tax whose income is offset by reductions in income or

other taxes. Moving Cooler estimates that carbon pricing would be 10 times more effective at reducing auto-related emissions than compact development, and that the vast majority of that reduction would come from people buying more fuel-efficient cars, not driving less.

Carbon pricing would allow people to choose for themselves whether they respond to higher fuel prices by buying more fuel-efficient cars, using alternative fuels, "eco-driving" in a more fuel-efficient manner, or driving less. Those who choose to drive less could also decide whether they want to live in high-density communities or continue to live in low-density communities but adjust other driving habits, perhaps by living closer to work, trip chaining, or shopping at one-stop supercenters instead of several smaller stores.

Carbon pricing would also have more immediate effects on energy use and carbon emissions than compact development, which will take decades to implement. Moving Cooler predicts that, in 2020, maximum use of carbon pricing would reduce auto-related emissions more than 30 times as much as maximum use of compact development, while in 2030 it would be 12 times as much.

These more-immediate effects mean that carbon pricing would be easier to evaluate and fine-tune in order to ensure that any emission reduction targets are met. By comparison, the slow deployment of compact development, combined with the indirect effects it has on driving and carbon emissions, means that decades will pass and hundreds of billions of dollars will be spent before we know if it is even working.

Finally, carbon pricing would not only be easier to implement than compact development, it would affect all producers of carbon emissions, notably including fossil-fuel-powered electrical plants. This means one tool can address far more sources of carbon emissions, while compact development mainly influences urban auto driving, which produces less than 13 percent of greenhouse gases.

No policy is immune to political abuse, and carbon taxes could easily turn into just one more source of pork barrel (as seems to have happened to the recent cap-and-trade proposal). If climate change worries prove baseless, a carbon tax is not even necessary.

But for those who insist on reducing carbon emissions, a true, revenue-neutral carbon tax makes far more sense than intrusive government policies aimed at coercing people out of their homes and cars and forcing them to live in politically correct multi-family housing and to ride on politically correct mass transit.

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Effect of Verification Cores on Tip Capacity of Drilled Shafts by Fulvio Tonon, Heejung Youn, Anay P. Raibagkar, 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/0_5825_1.pdf) (Feb 2009)

Highlights

- The degraded engineering properties of clay shales were estimated from laboratory tests.

The verification core refers to a core hole at least 1.5 m (5ft) long that must be excavated at the bottom of drilled shafts for visual inspection to determine whether the founding material is as strong as is called for in design. The clay shales at the perimeter of the excavated verification core hole may deteriorate as a result of air-drying and subsequent wetting that occurs during construction. The degraded engineering properties of clay shales were estimated from laboratory tests including: multi-stage triaxial tests, slake durability tests, and jar slake tests. The following are findings from laboratory tests:

- The principal stress difference of Del Rio Clay and Eagle Ford Shale is not affected by drying-duration, but is related to water content
- The principal stress difference of Taylor Marl and Navarro Shale decreases considerably as drying-duration increases
- The elastic modulus of all four clay shales drops significantly when clay shales are dried and wetted
- The slake durability index (SDI) tends to increase at low water content
- The engineering properties of Edwards Limestone and Austin Chalk are not affected by one cycle of drying and wetting
- Severe slaking of Eagle Ford Shale occurs after 8 hours of air drying and subsequent wetting
- Severe slaking of Del Rio Clay, Taylor Marl, and Navarro Shale occurs after 4 hours of air drying and wetting

In order to estimate the thickness of the degraded zone around the verification core hole, full-scale condition degradation tests were carried out near the City of Dallas, and NX-size investigation cores were obtained for laboratory testing. From extensive laboratory tests and the full-scale degradation condition test, the following determinations were made about the thickness of the degraded zone:

- The thickness of the degraded zone at the perimeter of the verification core does not exceed 12.7 cm (5 in) from the core wall of Eagle Ford Shale
- Based on jar slake test results, the maximum thickness (12.7 cm) of the degraded zone can be assumed for Eagle Ford Shale that is dried for 8 hours or longer and wetted and for other clay shales that are dried for 4 hours or longer and wetted
- The degraded zone at the bottom of drilled shafts is assumed to be reamed out before concrete pouring
- The dried clay shales that have not been re-wetted are assumed to be fresh;

consequently, the thickness is set to zero
- The maximum thickness (12.7 cm) can be assumed to be identical for all clay shales
- Engineering properties of Eagle Ford Shale is strongly affected by spatial variability

The effect of the verification core on the point bearing capacity of drilled shafts was investigated using finite element method (FEM) software, PLAXIS. The results from laboratory tests were converted to input material parameters for Mohr-Coulomb failure criterion. The load-displacement curves at the shaft tip were created from PLAXIS analyses, and the point bearing capacity was obtained at 5%D and 10%D displacement. The capacities obtained were used to calculate reduction factors that relate the point bearing capacity of the reference model (without a verification core) with that of "core models" (with a verification core). The reduction factors can be used to check whether the verification core hole will have an impact on shaft capacity. Based on the results of numerical analyses, the following conclusions are drawn:

- The effect of the verification core hole is dependent on the soil formation, core size, drying-duration, and the state of material filling the core hole upon concrete placement
- The reduction of point bearing capacity of "core models" is typically within 10% to a maximum of 14% (for Taylor Marl) of the capacity of the reference model
- The point bearing capacity of "dry pour" is the largest for all four clay shales tested
- The effect of the verification core hole increases as core size increases
- The effect of dry-duration is more significant in a larger diameter core hole
- Dewatering the verification core hole prior to concrete placement considerably improves the point bearing capacity of drilled shafts
- The point bearing capacity of the reference model tends to be larger at small displacement, while that of the "core model' tends to be larger at large displacement
- The verification core hole augered in weak clay shales such as Del Rio Clay improves the point bearing capacity (c.f. the principal stress difference of Del Rio Clay, which is typically less than 1 MPa)

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Hydraulic Performance of Bridge Rails by Randall J. Charbeneau, Brandon Klenzendorf, and Michael E. Barrett, 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/0_5492_1.pdf) (Jan 2009)

Highlights

- The impact of rails at a skewed orientation provides little to no adverse effects when compared to rails with no skew to the direction of flow.

The Federal Highway Administration (FHWA) requires the use of crash tested bridge rails on all new bridge construction and bridges scheduled for safety rehabilitation. This requirement is a concern for the Texas Department of Transportation (TxDOT) especially in the event of safety rehabilitation of bridges. The change to crash tested bridge rails may result in a rail of greater height and less open space than the existing rails. These changes could result in an increase in the upstream water elevation during extreme flood events due to reduced hydraulic performance. Such an increase in upstream water elevation may impact the 100-year floodplain elevations, which could require a FEMA floodplain map revision that can be costly and delay the project. In order to avoid such a potential delay, the hydraulic performance of various crash tested bridge rails was determined in order to get a better idea of the impacts of different rail types on the surrounding floodplains.

Report Objectives and Conclusions

The physical modeling program used in this research project consists of two separate series of investigations using different experimental facilities at the Center for Research in Water Resources (CRWR). The objectives of the first series of investigations were to develop rating curves and characterize the submergence effects in order to determine the hydraulic performance of individual bridge rails, bridge rails in series, and the effects of a skewed alignment between the bridge rail and channel. A mathematical model was developed to approximate the rating curves determined from the collected experimental data. Two separate mathematical models were utilized to characterize the impact that submergence effects have on the free-flow rating curve for each rail type. These mathematical models prove to be accurate in characterizing the hydraulic performance of bridge rails once the model parameters have been determined experimentally. The use of the rating curves, together with the submergence models, can be combined in order to predict a submerged rating curve that is representative of bridge rails in series. This prediction is accurate for rails with intermediate to no open space but over predicts the effects of rails with large amounts of open space. The impact of rails at a skewed orientation provides little to no adverse effects when compared to rails with no skew to the direction of flow.

The objectives of the second series of investigations were to develop a data set for the hydraulic performance of a simple bridge system including flow beneath and over the bridge decking. Four experimental setups were tested that include flow only under the bridge

substructure (culvert), flow over a bare bridge deck, flow over a bridge deck with solid rails, and flow over a bridge deck with open rails. Modifications to the rating curve models provide for good approximations to the collected data. In addition, the simple experimental bridge structure was modeled in HEC-RAS using default parameters and the results proved to be fairly accurate when compared to the collected data. Therefore, it was shown that HEC-RAS is able to simulate measured performance data for a simple bridge structure, and that model parameters can be adjusted based on separate data to allow improved simulation of structure hydraulic performance.

Finally, the methods of flow over bridge structures used in HEC-RAS were summarized, and possible alterations were suggested in order to incorporate the hydraulics of bridge rails. A simple example of accounting for the rail hydraulics was given and shown to be solved using an iterative approach. This method uses the high flow pressure/weir method in HEC-RAS, and consists of determining the appropriate weir coefficient such that the weir equation acts in a similar manner to the rail rating curve. The method of analysis that has been developed allows the user to directly incorporate the hydraulic performance of different bridge rail systems into floodplain investigations. This capability has not previously been available.

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Monitoring Scour Critical Bridges, *NCHRP Synthesis 396* by Beatrice E. Hunt, STV Incorporated, New York, N.Y. (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_396.pdf) (2009)

Highlights

- Scour is the primary cause of bridge failures in the United States.
- This synthesis is a report of the state of knowledge and practice for fixed scour monitoring of scour critical bridges.

Scour is the primary cause of bridge failures in the United States. Figure 1 shows statistics compiled by the Structures Division of the New York State Department of Transportation (DOT) and calculated using the National Bridge Failure Database. From 1966 to 2005, there have been at least 1,502 documented bridge failures. Of those bridge failures, 58% were the result of hydraulic conditions. Second on the list, but substantially behind, were collisions by ships, trucks, or trains, and overload. Earthquakes were a distant eighth on the list.

According to the FHWA, the number of bridges declared "scour critical" total more than 20,904. During and following the successful completion of NCHRP Project 21-03, *Instrumentation for Measuring Scour at Bridge Piers and Abutments*, more than 120 of these bridges were instrumented for scour measurements. Often these bridges are instrumented because the scour estimates appear overly conservative and it is prudent to observe scour activity during flood events before spending resources on other types of countermeasures. Other bridges are scheduled to be replaced, and monitoring is an alternative measure to help ensure the safety of the traveling public until the new bridge is completed.

This synthesis is a report of the state of knowledge and practice for fixed scour monitoring of scour critical bridges. It includes a review of the existing knowledge and research and an examination of current practice. The project included a survey of transportation agencies and other bridge owners to obtain their experiences with fixed scour monitoring systems. For those agencies that have not employed scour monitoring systems, their opinions were requested regarding problems and suggestions. Thirty-seven state DOTs responded to the survey. Information on scour monitoring for non-responding states was obtained from the literature review.

Many of these instrumented bridges have been monitored for more than ten years and some valuable field data have been accumulated. Exploring what data and associated evaluations are available will be useful for improving the technologies of predicting bridge scour as well as monitoring scour.

Thirty-two of the 50 states use, or have employed, fixed scour monitoring instrumentation on their highway bridges. A total of 120 bridge sites were identified that are using or have employed fixed monitors. The respondents to the survey provided information on their experiences with fixed scour monitoring installations and detailed data on at least one representative bridge site. Not surprisingly, the states that had the largest number of scour monitoring installations were

also locations with extreme weather conditions, Alaska and California. The monitoring systems used by the states, with the exception of time domain reflectometry, are described in the current FHWA guidelines on scour countermeasures and monitoring, Hydraulic Engineering Circular 23. The third edition of these guidelines, expected to be published in 2009, includes an expanded chapter on scour monitoring, with information on time domain reflectometers. The problems reported by the states were very similar. The difficulties with maintenance and repairs to the scour monitoring systems were the most common theme throughout the survey responses. The leading cause of damage to the systems was debris flows and accumulation. Other common problems were vandalism and corrosion.

The advancements that bridge owners would like to see for future fixed scour monitoring technology included the development of durable instrumentation, with increased reliability and longevity, decreased costs, and minimum or no maintenance. This equipment would include instrumentation that measures streambed scour and other hydraulic variables including water elevations and velocities. These would provide information for hydraulic design and analysis, and for the improvement of scour prediction methodologies.

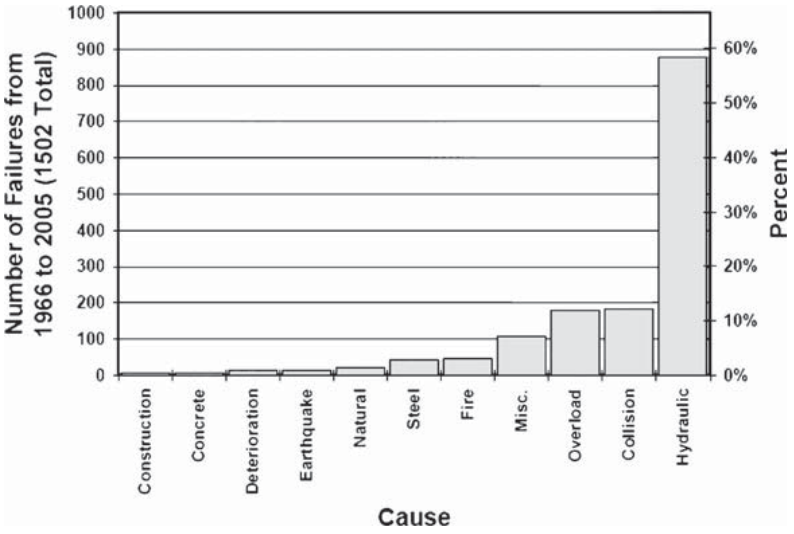

FIGURE 1 Causes of bridge failures in the United States

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Constructive Criticism by Bern Grush (bgrush@skymetercorp.com) in *TollTrans* (http://viewer.zmags.com/publication/59040127#/59040127/34) 2010)

Highlights
- Electronic tolling has great potential to help abate traffic congestion.

The USA largely stopped talking about congestion pricing when the New York City congestion plan died. But talk of road use charging under the rubric of Vehicle Miles Traveled (VMT) charging has more than picked up the slack. Ever since the New York legislature declined to vote -- forcing an end to the congestion pricing component of New York Mayor Bloomberg's PlaNYC -- talk has been mostly about funding and little about demand management.

Road-use charging thought falls into two domains. The first is heavy goods vehicles, as many transit one or more countries while returning little economic value to the countries through which they pass. Charging a road-use tax is a way to redress that loss. In Germany, for example, domestic operators receive a balancing refund. It is easy to argue that this is purely a funding matter, as opposed to a demand management matter. Interestingly, truck tolling in Switzerland and Austria appears to have encouraged a slight up-tick in rail use, while truck tolling in Germany has reduced fleet emissions as a result of pricing variation associated with emissions.

The second category is the charging of private vehicles to manage demand -- congestion pricing -- by charging a variable amount for distance traveled depending on where and when they travel, known in the EU as Time-Distance-Place or TDP charging.

In sharp contrast, the US road-use charging debate assumes a bankrupt Highway Trust Fund and a critical shortage of transportation funding across modalities and states. In a quick snapshot of recent highlights in the US debate regarding VMT, three key reports reveal a slippery, slope .

In January 2008, the National Surface Transportation Policy and Revenue Commission published a report that conduded with a call for a fuel tax increase while indicating a timid direction toward VMT charges as an eventual user fee in lieu of fuel taxes. In February 2009, the National Surface Transportation Infrastructure Financing Commission, published its report. This study was more assertive about the VMT fee idea. Then in September 2009, a US study, *Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding*, was released. This study was tasked. to answer how the US can deploy VMT fees by 2015.

The message contained in this third report was blunt by comparison to the first two. It offered nine ways to implement a VMT charge by 2015, three of which were recommended as best suited to requirements and constrained by the timeframe. By comparison, discussion of a fuel tax increase was conspicuously low.

Lack of funding is a temporary condition. It waxes and wanes. It can be hidden or rectified, but it is always politicized. The USA has a large-funding, problem because it appeased the gas tax demons for too many

decades. Europe has a much smaller funding problem because it taxed fuel more sensibly.

Congestion on the other hand is a permanent problem. The USA and Europe both experience it because most cities are spatially organized around a population sized 100 or more years ago. Human preferences for space tend toward desiring more of it. Cities spread then grow into each other. No one is at fault: it's what happens to any successful species within a limited physical space.

Europe has more automotive congestion than the USA because it houses the same population and cranks out the same GDP in half the geography. So the USA is much worse off in the funding domain and hardly better off in the congestion domain.

Unfortunately, the pressure from a few US senators to determine an immediately deployable, mileage-based replacement for the fuel tax limits solutions. Worse, it even hobbles our ability to examine what has already been done in the EU -- in metering, accuracy, interoperability, and privacy standards.

Two of the nine approaches in the NCHRP study involve GPS technology. The first, called course resolution GPS, can identify the jurisdiction or area of travel. The second, known as high: resolution GPS, would be accurate within 1-2m to determine the specific route of travel…enabling the greatest flexibility in pricing; per-mile rates could vary by vehicle characteristics, by jurisdiction, by area within jurisdictions, by specific route or road class, and by time.

The single greatest mistake the USA can make is to muscle its way out of a congested, under-funded, oil dependent, gas tax-broken, surface transportation mess with a pure mileage based system that does not allow an easy transition to a demand management system. That the US surface transportation problem is considered through the lens of bankruptcy rather than demand management will lead unavoidably to poor solutions -- solutions whose returns will not warrant their expense. Any charging program that costs billions to implement -- but does not have the built-in, automatic flexibility to manage the bigger, permanent blight of congestion -- will not be easy to decommission or replace. It will remain as a long-time barrier to solving the larger, deeper issue that plagues transportation.

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Improving Pedestrian and Motorist Safety Along Light Rail Alignments, *TCRP Report 137* by Don Cleghorn, Allison Clavelle, Jonathan Boone, Maurice Masliah, & Herbert S. Levinson (Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001; (202) 334-3213; http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_137.pdf) (2009)

Highlights

- This Project's goal was to provide guidelines for improving pedestrian and motorist safety along light rail transit (LRT) alignments.
- A list of nine recommendations is included.

The project had three central objectives:

- To develop a framework or template for collecting data for assessing pedestrian and motorist safety along LRT alignments,
- To identify and summarize pedestrian and motorist behavior, and
- To document best practices for improving pedestrian and motorist safety along LRT alignments.

To accomplish these objectives, a wide range of tasks was undertaken, and the project was divided into two phases. In Phase I, the project team undertook the following tasks:

- Literature review of LRT safety issues, safety measures, devices, practices, and new technologies relevant to LRT alignments.
- Survey of North American LRT agencies.
- Preliminary round of assembly and analysis of basic LRT crash data obtained from federal, state, and local transit agencies. Suitable data were difficult to obtain.
- Summary of all information gathered, and preparation of Phase 2 work plan.

In Phase II, the team undertook the following tasks:

- Consultation with representatives of the Federal Transit Administration (FTA), State Safety Oversight (SSO) agencies, and local LRT operating agencies. Follow-up requests for data at the agency, state, and national levels.
- Site visits to selected LRT agencies. Five agencies were visited: Utah Transit Authority, Salt Lake City, Utah; Metro Transit, Minneapolis, Minnesota; Hudson-Bergen Light Rail Line, Hudson County, New Jersey; San Francisco Municipal Railroad, San Francisco, California; and Santa Clara Valley Transportation Authority, Santa Clara County, California. The five site visits included system observation, safety workshops, and stakeholder consultation. The visits allowed for the collection of further information about data collection, collision records, the use of the Manual on Uniform Traffic Control Devices (MUTCD), and LRT safety issues. The visits provided valuable opportunities for detailed discussion of the effectiveness of treatments, risk assessment, data gathering, and data processing.
- Further review of LRT safety data, including: compilation and analysis of newly available data, review of data collection and storage procedures, and

development of recommendations concerning data collection and processing.
- Creation of detailed catalog of LRT-related safety treatments (characteristics, examples of installation, safety effectiveness)
- Development of a risk assessment methodology.

The second phase focused on successfully meeting project objective requirements that remained after Phase I and producing this final report, which documents all the project's activities, findings, and recommendations.

The first objective listed above (developing a framework for collecting LRT safety data) was the most straightforward. The second objective (pedestrian and motorist behavior) and the third objective (best practices for improving pedestrian and motorist safety along LRT alignments) presented major challenges. In particular, the detailed research statement called for a review of the effectiveness of treatments based on experience to date. The project team examined the collision data gathered as part of the project and conducted an extensive literature review, but found very little statistically significant information. The problem was amplified by the quantity and quality problems identified in the National Transit Database (NTD) and by the paucity of data available directly from local transit agencies. In response to these limitations, the project team took a dual approach: assessing treatments quantitatively where quantitative data were available, and collecting and summarizing qualitative and anecdotal information where quantitative data were not available.

Recommendations

Use proxies to assess the effectiveness of specific safety treatments without needing to wait for a significant number of collisions.

Follow four general treatment strategies: a) Give responsibility to the operators, b) Increase motorist, pedestrian, and cyclist awareness through active, appropriate information, c) Education, and d) Separate LRT space from the space occupied by other modes.

Continue to add to the LRT Catalog of Safety Treatments.

Use a standard LRT risk analysis methodology that addresses all of the elements listed in the LRT Alignment Risk Assessment Checklist.

Develop and implement a standardized, comprehensive, electronic LRT incident reporting form.

Provide a reporting form structure that can be easily transferred into a searchable electronic database.

Ensure that LRT collision reports include fields for storing geometric details and traffic exposure measures that apply to the specific incident site.

To support national-level analysis of LRT safety, an LRT crossing database should be created. This database should include for each alignment location (crossing or segment): details of geometry, control devices, and traffic exposure.

In the standardized electronic LRT incident reporting form, consider using fields that provide the most valuable information for researchers, designers, and operators.