Technology Helps Us Do Things Better: Virtual Weigh Stations, Other New Methods for Enforcing the Law Prolong Highway Life and Increase Vehicle Citations

Prepared by Ken Winter and Bryan Campbell, January 2009

VDOT Research Library
530 Edgemont Road
Charlottesville, VA 22903
Ph: (434) 293-1959
Fax: (434) 293-1990
Library.Circulation@VDOT.Virginia.gov

KEY SEARCH TERMS:

Weigh in Motion

Weigh in Motion Scales

High Speed Weigh in Motion

Overweight Trucks

Weight Measurement

Weigh Stations

Research Synthesis Bibliography No. 22

Research Synthesis Bibliographies (RSBs) are distillations of relevant transportation research on current topics of interest to researchers, engineers, and policy/decision makers. Sources cited are available for loan (or available through Interlibrary Loan) to VDOT employees through the VDOT Research Library.

Enforcing Truck Size and Weight Limits Through Automation and Coordination

It is well established that some truck drivers with overweight vehicles bypass stationary weigh stations to avoid being cited for weight violations or motor carrier safety violations. In 1992 the Virginia Transportation Research Council (VTRC) studied the issue of overweight trucks on Virginia's roadways, publishing reports on the avoidance of weigh stations by overweight trucks, and the use of FHWA's "Traffic Monitoring Guide" to develop a truck weight sampling procedure for use in Virginia. See: The avoidance of weigh stations in Virginia by overweight trucks / Ben Cottrell, 1992, and Using the Traffic monitoring guide to develop a truck weight sampling procedure for use in Virginia / Ben Cottrell, 1992.

Research at that time showed that a significant number of trucks on Virginia's roads were overweight, and that many drivers of those trucks sought to avoid existing weigh stations. VTRC recommended that VDOT seek ways to increase capacity at weigh stations to reduce "runbys" and to explore the increased use of Weigh-in-Motion (WIM) equipment as a more practical and effective way to improve enforcement overall. VTRC has not produced any reports on the topic since, though literature searches reveal hundreds of citations to peer-reviewed articles on this topic.

The following Research Synthesis Bibliography (RSB) seeks to explore the most relevant research published from 2000-2009 that may inform Virginia's current efforts to enhance enforcement, with a special emphasis on published research and expert presentations from Federal and state agencies. Even limiting our literature searches to the past 9 years reveals an enormous body of published research on WIM and Enforcement overseas. Only carefully selected citations are included in this RSB.

NEW APPROACHES UTILIZE MORE AUTOMATION

Automation-based approaches to support truck weight enforcement programs, commonly referred to as "virtual weigh stations," are being explored by many states, and a new movement is afoot to combine these technologies under an umbrella program tentatively being called the "Smart Roadside Initiative." This program would include: High Speed Weigh in Motion (HSWIM), vehicle dimension scanning, and transponder-enabled driver credentialing and vehicle safety inspection. For more information on this program, visit these links:
http://www.fmcsa.dot.gov/facts-research/art-smart-roadside.htm
http://www.itsa.org/itsa/files/pdf/Smart%20Roadside%20Working%20Group_Vision%20and%20Goals.pdf

Based on our current understanding of the problem, the VDOT Research Library compiled a sampling of citations to recent works addressing some of the issues that VDOT faces with regard to the need to maximize current resources in order to protect and preserve deficient structures and pavements against overweight trucks. The means by which other states are tackling these problems vary. In the most recent literature, states like California and Florida are looking to utilize automation more effectively in order to help maximize their enforcement efforts, especially against overweight trucks that avoid weigh stations.

There are few published reports or articles that deal with the exact topic of coordinating enforcement efforts by using advanced WIM technologies with targeting of high-priority roads and bridges through a joint DMV and DOT effort. However, the following article stands out as particularly relevant to Virginia's current needs. The full text is available through the VDOT Research Library. The citation is listed here:

Preservation Of Infrastructure By Using Weigh-In-Motion Coordinated Weight Enforcement
CITATION: J. Stephens, J. Carson, D. A. Hult, et al. , Transportation Research Record No. 1855, Transportation Research Board, 2003, Pg. p.-143-150.
ABSTRACT: The Montana Department of Transportation (DOT) has completed a pilot project in which data from a statewide network of weigh-in-motion (WIM) sensors were used to assist in scheduling weight-enforcement activities of patrol personnel. The purpose of the project was to determine if one of the division's objectives--reducing infrastructure damage from overweight vehicles--could be better realized by using WIM data when dispatching officers. Data for the project were obtained from Montana's state truck activities reporting system (STARS), which consists of WIM sites deployed around the state to collect information for a spectrum of Montana DOT activities. In this case, the STARS data were processed to determine the pavement damage caused by overweight vehicles each month during the baseline year. The trends identified from this analysis were used in the subsequent year to direct patrol efforts each month to the five sites that historically had experienced the greatest pavement damage from overweight vehicles. Officers were directed to the specific vehicle configurations historically responsible for the damage, as well as to their direction of travel and time of operation. During this year of WIM-directed enforcement, pavement damage from overweight vehicles decreased by 4.8 million equivalent single-axle load miles, and the percentage of vehicles operating over weight decreased by 20% across all STARS sites (both enforced and unenforced). While changes in loading patterns were observed during the enforcement activities (fewer overweight and more weight-compliant vehicles), the effectiveness of the focused enforcement in producing long-term changes in loading behaviors was uncertain.
ACCESS: http://dx.doi.org/10.3141/1855-18 (subscription only, available at the VDOT Research Library)

It should be noted that many states have been active in truck weight and size enforcement including: Florida, California, Washington State, Indiana, and New York. Also, it should be noted that we discovered references to the following research, which is underway at the time this RSB was compiled.

OVERSEAS ACTIVITIES MAY OUTPACE U.S. EFFORTS

In 2006 an FHWA scan of enforcement efforts in Europe observed a greater use of mobile enforcement activities and fewer fixed roadside weight facilities abroad than in the United States. Researchers working on the project recommended that U.S. implementations include a pilot installation of a bridge WIM system, a demonstration of “the European mobile enforcement approach” to prescreening suspected overweight vehicles, and a synthesis of existing research on linkages between overweight commercial motor vehicles and roadway safety. Their report Commercial Motor Vehicle Size and Weight Enforcement in Europe was released in 2007.

According to NCHRP 20-07/Task 254 [Active]: The FHWA Scan Team is now implementing a series of technology-based initiatives. They include Bridge Weigh in Motion, Virtual Weight Station Operating Practices, WIM Management Data, and Swiss Inspection Station. The Subcommittee on Highway Transport would like to promote a project aimed at DOT executives and law-enforcement officials around the country. The Subcommittee believes that a comprehensive report along with executive outreach sessions would accelerate a better understanding of the issues and lead to better programmatic direction to size and weight enforcement.”… Six briefing papers were prepared that describe various aspects of successful European practices and issues related to potential implementation in the United States, and they can be found below.

Size and Weight Management Agency-Wide Benefits

Bridge Infrastructure Preservation

Commercial Motor Vehicle Weight Enforcement

Commercial Motor Vehicle Size Enforcement

Oversize/Overweight Vehicles Permitting, Routing, and Monitoring

Weigh-in-Motion System Calibration

Source: http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=2335

EXPERT CONTACTS

In some instances the most effective course of action is not to read research reports, but to contact an individual with known expertise on a topic. The following "experts" have been identified and their contact information provided.

Jodi Carson, Ph.D., P.E. Investigator, NCHRP 20-07/Task 254 Texas Transportation Institute Texas A&M University System 3135 TAMU College Station, TX 77843-3135 ph. (512) 467-0946 · E-mail: j-carson@tamu.edu	Tom Kearney Statewide Planner, New York Division Federal Highway Administration Office of Freight Management and Operations (518) 431-4125 ext. 218 E-mail: Tom.Kearney@fhwa.dot.gov	Mike Onder Team Leader FHWA Freight Operations and Technology Team Phone: 202-366-2639 E-mail: Michael.Onder@dot.gov

--- Ken Winter and Bryan Campbell, VDOT Research Library, January 2009

DATABASES SEARCHED FOR THIS RSB

OCLC WorldCat
TRANSPORT
TRIS Online
VDOT Research Library Catalog
VDOT OneSearch
Google

OVERVIEW

Research Synthesis Bibliographies (RSBs) are selected lists of resources on current topics of interest to VDOT employees or divisions. When available, links to online documents are provided.

RSBs are "selective listings," organized and distilled from the larger universe of research materials to save the researcher's time. Selection criteria used by library staff include authority, relevance, and timeliness.

GETTING RESOURCES THROUGH THE LIBRARY

Full text copies of most resources listed in this document (or elsewhere) are available in the VDOT Research Library's collections, or through Interlibrary loan, through the Library. In many cases, the Library owns both virtual and hard copies of documents, as well as formats such as CD-ROM. While the VDOT Research Library must focus on its core patrons (VDOT staff) first, we also open our collections and services to transportation researchers and practitioners at other Virginia state agencies.

Library staff is available Monday-Friday 8:00-5:00. Please contact us if you have a reference question, a question about our lending policies, or need any other kind of help.

Reference Questions:
Ken Winter, Director Library/Info. Services
Ken.Winter@vdot.virginia.gov
434-293-1959

Library Circulation and InterLibrary Loans:
Misty Boos, Library Assistant
Misty.Boos@VDOT.Virginia.gov
434-293-1902

INITIAL READING: The following resources (listed in order of likely relevance) provide a logical place for initial exploration. It may be informative to explore these reports and articles in greater depth. These items are either available for immediate loan through the VDOT Research Library or can be quickly acquired through Interlibrary Loan and document delivery for VDOT patrons.

Preservation Of Infrastructure By Using Weigh-In-Motion Coordinated Weight Enforcement

CITATION: J. Stephens, J. Carson, D. A. Hult, et al. , Transportation Research Record No. 1855, Transportation Research Board, 2003, Pg. p.-143-150.

ABSTRACT: The Montana Department of Transportation (DOT) has completed a pilot project in which data from a statewide network of weigh-in-motion (WIM) sensors were used to assist in scheduling weight-enforcement activities of patrol personnel. The purpose of the project was to determine if one of the division's objectives--reducing infrastructure damage from overweight vehicles--could be better realized by using WIM data when dispatching officers. Data for the project were obtained from Montana's state truck activities reporting system (STARS), which consists of WIM sites deployed around the state to collect information for a spectrum of Montana DOT activities. In this case, the STARS data were processed to determine the pavement damage caused by overweight vehicles each month during the baseline year. The trends identified from this analysis were used in the subsequent year to direct patrol efforts each month to the five sites that historically had experienced the greatest pavement damage from overweight vehicles. Officers were directed to the specific vehicle configurations historically responsible for the damage, as well as to their direction of travel and time of operation. During this year of WIM-directed enforcement, pavement damage from overweight vehicles decreased by 4.8 million equivalent single-axle load miles, and the percentage of vehicles operating over weight decreased by 20% across all STARS sites (both enforced and unenforced). While changes in loading patterns were observed during the enforcement activities (fewer overweight and more weight-compliant vehicles), the effectiveness of the focused enforcement in producing long-term changes in loading behaviors was uncertain.

ACCESS: Available at the VDOT Research Library

ACCESS: http://dx.doi.org/10.3141/1855-18 (subscription only)

Infrastructure Preservation Using WIM Coordinated Weight Enforcement

CITATION: Jerry Stephens, Jodi Carson, Dennis A. Hult, et al. , Appearing in: National Research Council (U.S.). Transportation Research Board. Meeting (82nd : 2003 : Washington, D.C.). Compendium of papers CD-ROM, 2003. Partners for Advanced Transit and Highways (PATH); California Department of Transportation; University of California, Berkeley. Dept. of Electrical Engineering and Computer Science. Pg. 27-p.

ABSTRACT: The Montana Department of Transportation (MDT) just completed a pilot project in which data from a statewide network of weigh-in-motion (WIM) sensors were used to assist in scheduling weight enforcement activities of patrol personnel. The purpose of this project was to determine if one of the Division's objectives, namely, reducing infrastructure damage from overweight vehicles, could be better realized by using WIM data in dispatching officers. Data for the project were obtained from Montana's State Truck Activities Reporting System (STARS), which consists of WIM sites deployed around the state to collect information for a spectrum of MDT activities. In this case the STARS data were processed to determine the pavement damage caused by overweight vehicles each month during the baseline year. The trends identified from this analysis were used in the subsequent year to direct patrol efforts each month to the five sites that had historically experienced the greatest pavement damage from overweight vehicles. Officers were directed to the specific vehicle configurations historically responsible for the damage, as well as to their direction of travel and time of operation. Note: Publication Date: 2003. Transportation Research Board, Washington DC. Remarks: Paper prepared for presentation at the 82nd annual meeting of the Transportation Research Board, Washington, D.C., January 2003. Format: CD ROM.

ACCESS: Available at the VDOT Research Library.

Weight Enforcement and Evasion: Oregon Case Study
CITATION: J. G. Strathman and G. Theisen. , 2002. Oregon Department of Transportation; Federal Highway Administration. Pg. 51-p.
ABSTRACT: This study examines the incidence of overweight trucks and its relation to regulatory enforcement activity. Addressed are questions of scale operations in relation to weight violations and the effectiveness of enforcement levels, automated preclearance systems and weigh-in-motion (WIM) technology. The study also compares state-by-state enforcement intensity and penalty levels to understand their relative effective deterrence. To answer these questions the Oregon Department of Transportation (ODOT) identified an I-5 freight corridor and two potential bypass routes to collect data from three WIM sites. Data collection occurred before, during and after an extended closure of the I-5 weigh station. The traffic volume data did not indicate evasion behavior on the bypass routes, nor diversion to I-5 during closure. Only the I-5 site exhibited a statistically significant pattern of increase in mean GVW from baseline through closure (.4%) and a decrease of 1.2% following reopening. The incidence of overweight vehicles on I-5 also exhibited a statistically significant increase from 2.27% before closure to 3.67% during closure and a decline to 3.19% after re-opening. Additional analysis explored the incidence of overloading among ODOT Green Light preclearance program participants. Green Light program participants were less responsive to scale closure than non-participant vehicles. The study results suggest the following: 1) Relatively aggressive enforcement in Oregon (more weighings and stiffer fines for overweight violations) creates a climate where a single-site temporary suspension of weighing activity has less impact on trucking operations; 2) Weight enforcement activity at one site on I-5, the major West Coast freight corridor, may have little impact on interstate and international shipments; and 3) Green Light program participants may be either self-selecting compliant operators or, unwilling to jeopardize the benefits of the program by engaging in overloading.
ACCESS: http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/WTEnforcment.pdf

Commercial Motor Vehicle Size and Weight Enforcement in Europe
CITATION: Jeff G. Honefanger, Julie Strawhorn, Rick Athey, et al. , 2007. American Trade Initiatives; Federal Highway Administration; Federal Highway Administration; American Association of State Highway and Transportation Officials. Pg. 104p.
ABSTRACT: Continued growth in commerce and traffic congestion makes it difficult for industry to move freight economically without using larger and heavier loads. This trend challenges the effective and efficient monitoring of vehicle size and weight compliance. The Federal Highway Administration, American Association of State Highway and Transportation Officials, and National Cooperative Highway Research Program sponsored a scanning study to evaluate procedures and technologies for enforcing commercial motor vehicle size and weight laws in Belgium, France, Germany, the Netherlands, Slovenia, and Switzerland. The scan team learned that the European countries use various technologies, such as bridge weigh-in-motion systems, to improve the effectiveness and efficiency of motor vehicle size and weight enforcement. The team observed a greater use of mobile enforcement activities and fewer fixed roadside weight facilities in Europe than in the United States. The team's recommendations for U.S. implementation include a pilot installation of a bridge weigh-in- motion system, a demonstration of the European mobile enforcement approach to prescreening suspected overweight vehicles, and a synthesis of research on linkages between overweight commercial motor vehicles and roadway safety.
ACCESS: http://international.fhwa.dot.gov/pubs/pl07002/vsw_eu07.pdf

Virtual Weigh Station
CITATION: J. GREEN, A. Nichols, E. Allen, et al. , 2002. Purdue University/Indiana Dept of Transp JTRP; Indiana Department of Transportation; Federal Highway Administration. Pg. 315-p.
ABSTRACT: Overweight trucks shorten highway life and indirectly increase the costs of maintaining roads. Improved methods for enforcement of commercial vehicle weight laws may increase the number of overweight vehicles caught, thereby prolonging highway life. Improved enforcement may also reduce the number of illegally operating vehicles. This report describes the concept of using existing Indiana Department of Transportation

(INDOT) Weigh-In-Motion (WIM) equipment, a laptop computer, and wireless communication equipment, to develop a virtual weigh station screening tool. The virtual weigh station screening tool developed in this project allows officers to read the weights of vehicles crossing WIM scales, in real time, in their patrol cars. Giving officers this information increases the chances that the vehicles selected for weighing on portable scales are indeed overweight. This report documents the accuracy and precision evaluation performed on all the candidate WIM sites as well as the new infrastructure required to implement the virtual weigh station concept. The report describes several cases where significantly overweight vehicles were identified and impounded. For example, the procedures described in this report resulted in the identifying of the early morning hours as the best time for enforcement in Merrillville. As a result, on May 18, 2001 vehicles weighing 98,700 lb and 100,600 lb were stopped. Those vehicles were impounded and resulted in fines of $1,625.00 and $1,735.50, respectively. In February 2002, Commercial Vehicle Enforcement officers stopped ten trucks on US 24 near Fort Wayne using the virtual weigh station. Eight of the trucks were determined to be overweight and fined. The three heaviest trucks weighed 90,200 lb, 90,900 lb, and 91,100 lb, resulting in fines of $1,099.50, $1,169.50, and $1,189.50, respectively. On April 12, 2002, another enforcement was conducted on I-65 near Merrillville. Three trucks were stopped based on the virtual weigh station data. One of the trucks weighed 87,400 lb, resulting in a $529.50 fine. The report concludes by making recommendations designed to improve the quality of WIM data and facilitate deployment by the Commercial Vehicle Enforcement Division.
ACCESS:
http://rebar.ecn.purdue.edu/JTRP_Completed_Project_Documents/SPR_2481/FinalReport/spr_2481_Form1700.pdf

Bypass Surgery: At Punta Gorda in Charlotte County, Florida DOT Has Been Proving the Virtual Weigh Station Concept
CITATION: Anonymous , ITS International, 2008. Route One Publishing Limited. Vol. 14, No. 2, Pg. pp-NA8-NA9.
ABSTRACT: In this article the author describes efforts by the Florida Department of Transportation (FDOT) to curb avoidance of weigh station facilities by Heavy Goods Vehicle (HGV) drivers in Punta Gorda. The deployed Virtual Weight Station (VMS) utilizes a License Plate Recognition (LPR) system on exit and on ramps for the relevant freeway section. The installed WIM detectors trigger the LPR-equipped cameras and so determine compliance for HGV. If it is found that the vehicle is not compliant, a FDOT Motor Carrier Compliance Office (MCCO) computer determines the penalty. It is noted that the employed equipment array also includes a light source so imaging information can be acquired during night hours. Although infrared (IR) light was previously used for nighttime detection, it was found to have some practical drawbacks in terms of vehicle reflectivity.
ACCESS: Contact the VDOT Research Library for availability.

Coordination of Commercial Vehicle Data Collected By Automatic Traffic Counter (ATC) And Weigh-In-Motion (WIM)
CITATION: S. L. Skszek. , 2003. Skszek (Sherry L); Arizona Department of Transportation; Federal Highway Administration. Pg. 90-p.
ABSTRACT: The purpose of this report is to examine the current state of commercial vehicle data handling in an effort to identify ways in which the Arizona Department of Transportation's (ADOT's) practices can be improved. This is done through a threefold approach that includes a literature review, survey of other states' practices, and an ADOT needs assessment. The literature review shows an absence of a best practices consensus relative to coordination of commercial vehicle data. Obstacles to developing an effective program appear to be lack of funding, data quality, timeliness of delivery, and incompatible data formats. Success is contingent on inter- and intra-agency cooperation among data collection units. A survey of state practices showed data collection is typically centralized in one or two departments. Data collection is part of a permanent program using permanent data collection sites supplemented by portable equipment. No apparent method of operation led to an "effective" or "very effective" self-rating. Commercial vehicle data are primarily used to meet federal reporting requirements with limited use for

size and weight enforcement. The needs assessment showed the lack of commercial vehicle data for effective size and weight enforcement as the area where the current system falls short of user needs. This is due in part to the lack of coordination and communication between data collection units. Additionally, a large percentage of traffic count and classification equipment is in need of repair or replacement. Weigh-in-motion equipment is absent on critical interstate highways and truck bypass routes.
ACCESS: http://www.azdot.gov/TPD/ATRC/publications/project_reports/PDF/AZ526.pdf

Solving Highway Weight Problems : Virtual Weigh-In-Motion Systems Eliminate Opportunities For Trucks To Bypass Weigh Stations
CITATION: Tim Gregorski. , Transportation management + engineering.Vol.6, no.6, 2002. Pg. p.-30.
ABSTRACT: This article descries a high-tech approach to curbing overweight vehicles on roadways through the Virtual Weigh-in-Motion (WIM) technology. The system has a sensor in the roadway that interfaces with roadside controller. It records data 24 hours a day, monitoring specific sensor sites, thus enabling violators such as those with overweight vehicles to be captured. Note: Publication Date: December 2001/January 2002.
ACCESS: Contact the VDOT Research Library for availability.

***RECENT PRESENTATIONS*:** The following presentations (listed in order of likely relevance) were found online using free-Web search tools. They may provide insights into the current state of the art in truck size and weight enforcement technologies.

Commercial Motor Vehicle Size and Weight (VSW) Enforcement: Scan Tour Overview, June 16-July 2, 2006 AASHTO, U.S. DOT, NCHRP, By Mike Onder, Freight Operations and Technology Team, FHWA
ACCESS:
http://www.itsa.org/itsa/files/presentations/MikeOnder_FHWA%20presentation_SCAN_10.24.06.ppt

Truck Size and Weight Enforcement Technologies Project Smart Roadside Workshop, April 28, 2008
ACCESS: http://www.fmcsa.dot.gov/facts-research/presentations/smart-roadside-workshop/Onder-TSW-Enforcement.pdf

Truck Size and Weight enforcement (2006)
ACCESS: http://freight.transportation.org/doc/hwy/dc08/scoht_size.ppt

Commercial Motor Vehicle Size and Weight Enforcement in Europe
ACCESS: http://international.fhwa.dot.gov/pubs/pl07002/vsw_eu07.pdf

Commercial Vehicle Inspection Stations
ACCESS: http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_TE/FDOT_BD441_rpt.pdf

INTERNATIONAL EFFORTS: The following resources (listed alphabetically, by title) offer a glimpse into the world of targeted enforcement of truck weight used outside of the United States. These items are either available for immediate loan through the VDOT Research Library or can be quickly acquired through Interlibrary Loan and document delivery for VDOT patrons.

Automatic Overloading Control Test Site in France
CITATION: Stanczyk, D., and D. Labry, "Automatic Overloading Control Test Site in France," Fourth International Conference on Weigh-in-Motion, Taipei, Taiwan, 2005.
ACCESS: Contact the VDOT Research Library for availability.

Commercial Vehicle Safety: Technology and Practice in Europe
CITATION: Hartman, K., et al., *Commercial Vehicle Safety: Technology and Practice in Europe,* Federal Highway Administration, Washington, DC, 2000.
ACCESS: Contact the VDOT Research Library for availability.

Effective Use of Weigh-in-Motion Data: The Netherlands Case Study
CITATION: Anonymous , 2007. Federal Transit Administration. Pg. 6p.
ABSTRACT: Transportation and law enforcement agencies in the Netherlands have developed a robust weigh-in-motion (WIM) data management system that supports a broad array of vehicle weight regulation and enforcement activities, as well as long-term planning and decisionmaking. The system, which Dutch officials describe as "a better way of doing business," has potential for application in U.S. states that want to expand their use of WIM data. The Netherlands' WIM data management system was developed by the Centre for Transport and Navigation of the Ministry of Transport, Public Works, and Water Management (www.verkeerenwaterstaat.nl/english), in partnership with the National Police Services Agency (www.politie.nl/KLPD) and the Ministry's Inspectorate of Transport and Water Management (www.ivw.nl). A team of U.S. transportation experts observed the system during the 2006 Commercial Motor Vehicle Size and Weight Enforcement Scanning Study, sponsored by the Federal Highway Administration, American Association of State Highway and Transportation Officials, and National Cooperative Highway Research Program. The Dutch have integrated extensive quality control and quality assurance protocols into their system, significantly enhancing confidence in the vehicle information provided. This technical brief describes how WIM data are captured, processed, stored, reported, and used to support vehicle weight regulation and enforcement in the Netherlands.
ACCESS: http://international.fhwa.dot.gov/pubs/pl07028/pl07028.pdf

Evaluation of the Economic Feasibility of Weigh-In-Motion in Canada
CITATION: L. ZHANG, C. Haas and SL TIGHE. , Appearing in: 2008 Annual Conference of the Transportation Association of Canada, 2008. Transportation Association of Canada. Pg. 18-p.
ABSTRACT: Over weighted trucks are the cause of many issues including pavement premature deterioration, mistimed maintenance, and high pavement life cycle cost. To comply with weight enforcement and to preserve highway, Weigh-In-Motion (WIM) has been focused on using state-of-the-art sensing technology to continuously collect vehicle weights, speeds, vehicle classes, and various types of traffic data as vehicles travel over a set of sensors (embedded or portable), without interruption of traffic flows. This paper will examine the capability and applicability of WIM from an economic perspective in Canada. A complete benefit-cost study in three aspects, delay time benefit, safety benefit, and level of enforcement benefit, for Canadian road network are quantified. Variables that alter the magnitudes of the benefits and costs are carefully chosen. A sensitivity analysis and a break-even analysis are performed. An application of WIM in Canada is addressed to demonstrate the economic feasibility. The analysis result shows that an integrated benefit-cost ratio of 12 can be achieved. WIM deployment is economically feasible for the circumstances in Canada.
ACCESS: Contact the VDOT Research Library for availability.

European Test of WIM Systems—Continental Motorway Test (CMT II) on the Motorway A31
CITATION: Stanczyk, D., S. Jehaes, B. Jacob, B. McCall, and E. O'Brien, "European Test of WIM Systems— Continental Motorway Test (CMT II) on the Motorway A31," Third International Conference on Weigh-in-Motion, Orlando, FL, 2002.
ACCESS: Contact the VDOT Research Library for availability.

Evaluation of Dynamic Effects of Heavy Vehicles on Bridge Fatigue
CITATION: Jacob, B., and D. Labry, "Evaluation of Dynamic Effects of Heavy Vehicles on Bridge Fatigue,"*Proceedings of the Seventh International Symposium on Heavy Vehicle*

Weights and Dimensions, Delft, Netherlands, June 16–20, 2002.
ACCESS: Contact the VDOT Research Library for availability.

Fair and Efficient: The Distance-Related Heavy Vehicle Fee (HVF) in Switzerland
CITATION: Federal Office for Spatial Development (ARE), *Fair and Efficient: The Distance-Related Heavy Vehicle Fee (HVF) in Switzerland,* Department of the Environment, Transport, Energy, and Communications, Bern, Switzerland, 2004.
ACCESS: http://www.are.admin.ch/themen/verkehr/00250/00461/index.html?

The French National WIM Network 'SIREDO'
CITATION: Rambeau, S., C. Follin, and D. Stanczyk, "The French National WIM Network 'SIREDO,'" in *Pre-Proceedings of the Second European Conference on Weigh-in-Motion,* eds. E.J. O'Brien and B. Jacob, Lisbon, Portugal, Sept. 14–16, 1998, COST 323, Luxembourg, 47–54.
ACCESS: Contact the VDOT Research Library for availability.

Long-Term Pavement Performance Monitoring Of A Swiss Motorway
CITATION: C. Raab, L. D. Poulikakos, P. Anderegg, et al. , Appearing in: Third International Conference on Weigh-in-Motion (ICWIM3), 2002. Iowa State University, Ames; Federal Highway Administration; Florida Department of Transportation; Center for Transportation Research and Education. Pg. p.-335-340.
ACCESS: Contact the VDOT Research Library for availability.

Overloaded Vehicles Screening
CITATION: Stanczyk, D., and Y. Marchadour, "Overloaded Vehicles Screening," in *Proceedings of the Fourth International Conference on Weigh-in-Motion,* Taipei, Taiwan, Feb. 20–23, 2005.
ACCESS: Contact the VDOT Research Library for availability.

Procedures For Acceptance of WIM Systems for Automatic Enforcement of Overloading
CITATION: Henny, R., "Procedures For Acceptance of WIM Systems for Automatic Enforcement of Overloading," Third International Conference on Weigh-in-Motion, Orlando, FL, 2002.
ACCESS: Contact the VDOT Research Library for availability.

Recent Development And Implementation Of Weigh-In-Motion In Some Asian Cuntries
CITATION: C-p Chou and Y-H Chen. , Appearing in: Third International Conference on Weigh-in-Motion (ICWIM3), 2002. Iowa State University, Ames; Federal Highway Administration; Florida Department of Transportation; Center for Transportation Research and Education. Pg. p.-25-34.
ABSTRACT: Due to the rapid growth of economics in the past decades, most of the Asian countries have faced the accompanied problem of over-size and weight of heavy vehicles. It causes a big burden to the traditional static weight stations and police enforcement. Through the technical development of Weigh-in-Motion (WIM) it has been found that efficiency of either pre-screening or direct enforcement of overloaded heavy vehicles can be improved significantly. This paper mainly describes some examples of using WIM to help manage and protect highway infrastructures and even enforce overloaded vehicles in some Asian countries, such as Taiwan, Japan, China, South Korea, and Hong Kong.
ACCESS: Contact the VDOT Research Library for availability.

Remote WIM Systems in Alpine Tunnels
CITATION: Doupal, E., and R. Calrerara, "Remote WIM Systems in Alpine Tunnels," First International Conference on Virtual and Remote Weigh Stations, Orlando, FL, 2004.
ACCESS: Contact the VDOT Research Library for availability.

REMOVE, Requirements for Enforcement of Overloaded Vehicles in Europe

CITATION: Van Loo, F., and R. Henny, "REMOVE, Requirements for Enforcement of Overloaded Vehicles in Europe," Fourth International Conference on Weigh-in-Motion, Taipei, Taiwan, 2005.
ACCESS: Contact the VDOT Research Library for availability.

Slovenian Experience in Using WIM Data For Road Planning and Maintenance
CITATION: Brozovic, R., V. Vodopivec, and A. Žnidaric, "Slovenian Experience in Using WIM Data For Road Planning and Maintenance," Fourth International Conference on Weigh-in-Motion, Taipei, Taiwan, 2005.
ACCESS: Contact the VDOT Research Library for availability.

Test of Multiple Sensor and Four Portable WIM Systems
CITATION: Blab, R., and B. Jacob, "Test of Multiple Sensor and Four Portable WIM Systems," *International Journal of Heavy Vehicle Systems,* Volume 7, Issue 2/3, 2000.
ACCESS: Contact the VDOT Research Library for availability.

Test of WIM Sensors and Systems on an Urban Road
CITATION: Caprez, M., E. Doupal, B. Jacob, A. O'Conner, and E. O'Brien, "Test of WIM Sensors and Systems on an Urban Road," *International Journal of Heavy Vehicle Systems,* Volume 7, Issue 2/3, 2000.
ACCESS: Contact the VDOT Research Library for availability.

Weigh-in-Motion of Axles and Vehicles for Europe, Final Report of the Project WAVE
CITATION: Jacob, B., *Weigh-in-Motion of Axles and Vehicles for Europe, Final Report of the Project WAVE,* LCPC, Paris, France, 2002.
ACCESS: Contact the VDOT Research Library for availability.

WIM-HAND, The Development of a Weigh-in-Motion System for Automatic Enforcement of Overloading
CITATION: Van Loo, F., "WIM-HAND, The Development of a Weigh-in-Motion System for Automatic Enforcement of Overloading," Eighth World Congress on Intelligent Transportation Systems, Sydney, Australia, 2001.
ACCESS: Contact the VDOT Research Library for availability.

OTHER CITATIONS: The following resources (listed alphabetically, by title) may be useful to Virginia state agencies seeking to coordinate enforcement of overweight truck limits in Virginia. These items are either available for immediate loan through the VDOT Research Library or can be quickly acquired for VDOT patrons through Interlibrary Loan.

Bridge Weigh-In-Motion Systems Using Stringers Of Plate Girder Bridges
CITATION: T. Ojio and K. Yamada. , Appearing in: Third International Conference on Weigh-in-Motion (ICWIM3), 2002. Iowa State University, Ames; Federal Highway Administration; Florida Department of Transportation; Center for Transportation Research and Education. Pg. p.-209-218.
ABSTRACT: A Bridge Weigh-in-Motion system without axle detector is presented. Two stringers located under the deck of plate girder are used for each lane. Velocity is estimated by comparing strain response waves obtained for the two stringers. Gross vehicle weights are estimated by integration of strain response wave and considering truck velocity. The COST-323 accuracy class was found to be D+(20) OR D (25) for test trucks. Wheel spacing can also be estimated from strain response waves. Measurements are carried out for three plate-girder bridges under service condition. Experimental site results and truck load statistics, for a single week, are described.
ACCESS: Contact the VDOT Research Library for availability.

Commercial Vehicle Reidentification Using WIM and AVC Data
CITATION: Mecit Cetin and Andrew P. Nichols. , Appearing in: Transportation Research

Board 86th Annual Meeting, 2007. Transportation Research Board. Pg. 17p.
ABSTRACT: This paper presents a new approach to the vehicle re-identification problem in the context of matching commercial vehicles crossing two adjacent weigh-in-motion stations at a commercial vehicle enforcement weigh station. A Bayesian formulation that utilizes finite mixture models to represent probability distributions of the attribute data is developed. Multiple combinations of vehicle attribute data (e.g., axle spacing, vehicle length, axle weights) are analyzed to represent different data collection scenarios (e.g., weigh-in-motion or vehicle classification only). The Bayesian model matches individual vehicles based on the posterior probabilities calculated from the vehicle attribute data and time stamps observed at the two stations. The results of the proposed method are promising with a mismatch error rate of 3% on a test dataset with more than 900 samples. For comparison purposes, another matching algorithm based on the nearest squared-distance is also developed. In all cases, the proposed Bayesian method outperforms this nearest neighbor method. The specific application that provides the framework for this paper is tracking individual vehicles through a weigh station system in order to improve enforcement efficiency and effectiveness. The paper discusses other potential applications of the re-identification algorithm and the associated future research.
ACCESS: http://pubsindex.trb.org/orderform.html

A Comparison Of Data Collected By Two Weigh-In-Motion (WIM) Systems Monitoring Identical Traffic On The Same Segment Of Roadway
CITATION: Curtis Dahlin and Maggi Chalkline. , Appearing in: National Research Council (U.S.). Transportation Research Board. Meeting (81st : 2002 : Washington, D.C.). Preprint CD-ROM, 2002. Jamiat al-Imarat al-Arabiyah al-Muttahidah; Partners for Advanced Transit and Highways (PATH); Partners for Advanced Transit and Highways (PATH); University of Minnesota, Twin Cities; University of California, Irvine; Joint Transportation Resear(TRUNCATED). Pg. 18-p.
ABSTRACT: There are two continuously operating Weigh-in-Motion (WIM) systems located at the MnROAD test facility on I-94 in Minnesota. They are located about 3.2 kilometers (2 miles) apart with no interchange separating them. They monitor the same mainline traffic in both westbound lanes. The systems are International Road Dynamics (IRD's) hydraulic load cell installed in 1989 and the Kistler quartz sensors installed in 2000. This report discusses the similarities and differences in the data simultaneously collected by both systems. Similarities are noted in the volume of vehicles monitored, including the Type 9, the 5-axle semis. There are also some similarities in the weight distributions of major truck types including Types 9 and 11 the latter being 5-axle twin trailers. At the same time, there are differences in the weight distributions. The Kistler quartz sensors tend to weigh empty 5-axle semis too heavy when the system is calibrated to weigh loaded 5-axle semis. The distribution of weight on tandems is also analyzed as well as a match-up of specific trucks weighed by both systems. This match-up of specific trucks provides a glimpse in the role and degree of dynamics when using WIM to collect truck weight data. Finally, the variability of data collected by each system is analyzed. The general conclusion of this study is that the two systems appear to collect data of similar quality and variability particularly when road profile information is considered. Note: Publication Date: 2002. Transportation Research Board, Washington DC. Remarks: Paper 02-2997 prepared for presentation at the 81st annual meeting of the Transportation Research Board, Washington, D.C. January 2002. Format: CD ROM.
ACCESS: Contact the VDOT Research Library for availability.

CVISN Home Page : Commercial Vehicle Information Systems and Networks
CITATION: Anonymous , 2003. Washington State Department of Transportation.
ABSTRACT: Much of the Washington State's transportation infrastructure is aging. This is especially evident in the fifteen commercial vehicle weighing stations along the interstate routes. The Washington State Patrol Commercial Vehicle Enforcement Officers who staff the weighing stations perform a myriad of compliance operations related to commercial vehicles. Due to excessive truck volume it has become common to suspend compliance operations at these sites. This action (bypassing potentially illegal or unsafe trucks) is not in the best interests of public safety or regulatory compliance criteria. The Commercial

Vehicle Information Systems and Networks (CVISN) program uses Intelligent Transportation Systems technology to promote the safe and legal movement of commercial vehicle traffic. The CVISN transponder program allows trucks to bypass weigh stations by electronically verifying a truck's legal weight and credentials as the truck continues down the road at freeway speeds. The Weigh-in-Motion (WIM) system is imbedded in the roadway about a half-mile ahead of the weigh station and weighs the truck as it passes over it. At the same time, the Automatic Vehicle Identification (AVI) device communicates electronically to verify each transponder-equipped truck's weight size, carrier registration, and safety record while the truck continues moving. This website explains the program and how carriers can participate, saving everyone time and money in the process. Note: Publication Date: 2003. Remarks: Website viewed June 27, 2003. Format: website.
ACCESS: http://www.cvisn.wsdot.wa.gov/

Data Weigh-In-Motion Program In California
CITATION: Anonymous , 2003. California Department of Transportation.
ABSTRACT: Weigh-in-Motion systems have been in use in California for collection of vehicular data since 1987. Each system provides the following data: Axle and gross weight; Axle spacing and vehicle classification; and Speed. Data WIM systems provide round-the-clock traffic information at key locations on California highway system. The information gathered is essential for the following functions: Pavement studies; Highway monitoring and capacity studies; Accident rate calculations; Analysis of truck transport practices. Currently there are 85 data WIM collection sites in operation across California. More sites are under construction and further expansion of WIM systems are planned for the coming years. Note: Publication Date: 2003. Remarks: Website viewed May 10, 2003. Format: website.
ACCESS: http://www.dot.ca.gov/hq/traffops/trucks/datawim/

Data, Survey Methods, Traffic Monitoring, and Asset Management
CITATION: Anonymous , Transportation Research Record: Journal of the Transportation Research Board, 2007. Transportation Research Board. No. 1993, Pg. 184p.
ABSTRACT: This collection of 22 papers is concerned with traffic monitoring, asset management, and survey methods. Specific topics discussed include the following: revenue risk mitigation in transportation project financing; traffic sign asset management; estimating highway investment requirements; estimating design hourly volumes; traffic prediction; digital dashboards; random count site selection; wireless location technology-based traffic monitoring; traffic flow impact on travel time variability; transferability of National Household Travel Survey data; impact of nonresponse and weighting in a travel survey; data integration impact on travel behavior indicators; iterative proportional fitting algorithm for combining traffic count data with missing dimensions; an electronic freight theft management system using Internet-based mapping; regional routing model for strategic waterway analysis; Highway Capacity Manual adjustment factor for annual weekday to annual average daily traffic; automated consensus-based data verification; enhancing truck data accuracy using dual-loop event data; video-based vehicle detection and classification system; gross vehicle weight distributions from weigh-in-motion data; detection and tracking of vehicle base fronts for traffic counts and speeds; and customizing quality assessment techniques for traffic data archives.
ACCESS: Contact the VDOT Research Library for availability.

Determination Of Practical ESALS Per Truck Values On Indiana Roads
CITATION: S. Gulen, J. Nagle, J. Weaver, et al. , 2000. Purdue University/Indiana Dept of Transp JTRP; Indiana Department of Transportation; Federal Highway Administration. Pg. 28-p.
ABSTRACT: The Indiana Department of Transportation (INDOT) has been using ESAL (Equivalent Single Axle Load) values for pavement design. The current ESAL values were obtained in the late 1970. However, truck deregulation and higher allowable maximum loads have increased the 1970s values. Updated ESAL values are needed for better road designs. The 1998 and 1999 traffic data for all Weight-in-Motion (WIM) stations were

obtained and used to compute updated ESAL values for multiple unit trucks (Class 9/F-9) and single unit trucks (Class 5, 6 and 7). Statistical analyses indicated that average ESAL values for 1998 and 1999 are statistically the same, but the average ESAL values for interstates roads and non-interstate roads are not all statistically the same. Somw WIM stations were deleted for definite calibration problems. Due to other calibration deficiencies, the data was refined before final ESAL computations. Then the following ESAL values were computed and recommended to be used for future INDOT road designs: For multiple unit trucks (Class 9): 1.3 ESAL/truck for flexible pavements, and 2.0 ESAL/truck for rigid pavements. For single unit trucks (Class 5, 6 and 7): 0.6 ESAL/truck for flexible pavements, and 0.9 ESAL/trucks for rigid pavements.
ACCESS:
http://rebar.ecn.purdue.edu/JTRP_Completed_Project_Documents/SPR_2331/FinalReport/spr_2331_final.pdf

Development and Evaluation Of Fiber Optic Sensors
CITATION: E. Udd and M. Kunzler. , 2003. Blue Road Research; Oregon Department of Transportation; Federal Highway Administration. Pg. 59-p.
ABSTRACT: This study investigated the feasibility of using fiber optic sensors to capture traffic data. Funding from the study was used to develop a prototype sensor using fiber Bragg gratings (FBG) technology. The sensor was tested on a high volume portland cement concrete highway and found to be feasible for use in monitoring light and heavy traffic. Signals from the sensor were processed with a demodulator system, and captured on a computer. For testing purposes, the signal was converted to a scaled analog voltage signal and successfully output to a conventional traffic classifier recorder. The sensors have the potential for long-lasting, cost-effective solutions in vehicle classification applications. With modification, the FBG strain sensor shows potential for use in weigh-in-motion applications. The system is sensitive enough to detect adjacent lane traffic, opening possibilities of shoulder area monitoring for less traffic disruption and increased safety. With two sensors, the system can capture speeds as well as weights of both sides of a vehicle. Future development of dedicated demodulator/interfacing electronic hardware and auto-tuning grating system could eventually lead to cost effective solutions for traffic classification and weigh-in-motion applications.
ACCESS:
http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/DevAndEvalFiberOptics.pdf

Development and Influence of Statewide Axle Load Spectra on Flexible Pavement Performance
CITATION: Nam H. Tran and Kevin D. Hall. , Transportation Research Record: Journal of the Transportation Research Board, 2007. Transportation Research Board. No. 2037, Pg. pp-106-114.
ABSTRACT: The "Mechanistic–Empirical Pavement Design Guide" (MEPDG) developed under NCHRP Project 1-37A requires new inputs for traffic characterization. One important traffic input is axle load distribution factors, or axle load spectra. These spectra represent the percentage of the total axle applications within each load interval for single, tandem, tridem, and quad axles. The Arkansas State Highway and Transportation Department sponsored research to develop statewide axle load spectra and evaluate the significance of the developed inputs in the MEPDG. Of 25 weigh-in-motion sites selected for this study, only 10 stations provided good weight data for development of statewide axle load spectra. On the basis of the available weight data, statewide axle load spectra for single, tandem, and tridem axles were developed. However, the data contained few quad axles; therefore, statewide quad-axle load spectra were not generated. A sensitivity analysis related to the axle load spectra showed a significant difference in predicted pavement performance resulting from the statewide and MEPDG default axle load spectra. Therefore, the state-specific axle load spectra are recommended for implementation of the MEPDG in Arkansas and updated periodically unless no significant changes are observed in the future.
ACCESS: http://dx.doi.org/10.3141/2037-10

Development, Deployment, and Evaluation of a Remote Monitoring System and a Virtual Weigh Station
CITATION: J. D. Crabtree, D. Q. Hunsucker and J. R. Walton. , 2005. University of Kentucky, Lexington; Kentucky Transportation Cabinet; Federal Motor Carrier Safety Administration. Pg. 18p.
ABSTRACT: In order to extend commercial vehicle enforcement coverage to routes that are not monitored by fixed weigh stations, Kentucky has developed and implemented a Remote Monitoring System (RMS) and a Virtual Weigh Station (VWS). The RMS captures images of passing trucks (from the side) and transmits those images to a nearby weigh station. Station personnel can view the images, read the United States Department of Transportation (USDOT) number, and check the number against Kentucky's Clearninghouse of motor carrier data. When a problem is detected with the carrier's registration, taxes, or safety record, an officer can be dispatched to intercept the truck, perform the necessary checks, and, if appropriate, take corrective action. The VWS provides the same functionality as the RMS, but adds a weigh-in-motion system, so that enforcement personnel can also screen trucks for apparent weight violations. Preliminary assessments of the performance of the RMS and VWS have been performed. This report describes the RMS and VWS concepts, discusses the results of the prelimary assessments, and presents recommendations for moving forward with additional deployments and testing.
ACCESS: http://www.ktc.uky.edu/Reports/KTC_05_38_SPR_240_02_1F.pdf

DP121, Weigh-In-Motion Technology
CITATION: Anonymous , 2001. Oak Ridge National Laboratory; Federal Motor Carrier Safety Administration.
ABSTRACT: This website, part of Demonstration Project 121 (DP 121) is produced by the Oak Ridge National Laboratory for the Federal Highway Administration. The website summary follows: "On the surface, weigh- in-motion would appear to be the holy grail of weighing devices capable of providing accurate weight measurements quickly and efficiently. This statement is, in fact, true in some applications under certain conditions. However, like everything else, WIM systems have their limitations. This web-site is designed to help you sort through these limitations and the many options available to you when: choosing a WIM system based on your needs, preferences, and available options, and using a WIM system to maximize its utility for your specific application. As you browse, you will find valuable information on technologies, applications, installation and maintenance procedures, sources of error, cost and performance rules- of-thumb, case studies, vendors, and products. The web-site also includes a: reference library to further educate you on terminology technologies, etc., and a news and events page to inform you on such topics as the latest technologies, upcoming events, recent case studies, vendor updates, and noteworthy publications. Note: Publication Date: 2001. Remarks: Website viewed November 12, 2001. Format: website.
ACCESS: Contact the VDOT Research Library for availability.

Enforcement Procedures Using Weigh-In-Motion Systems In Indiana
CITATION: A. Nichols, D. Bullock, G. Boruff, et al. , Appearing in: 9th World Congress on Intelligent Transport Systems, 2002. ITS America. Pg. 12p.
ABSTRACT: Identifying overweight commercial vehicles is often a difficult task. To enforce weight laws, Indiana operates a small number of static weigh stations located near state borders on primary routes and deploys mobile commercial vehicle enforcement vehicles equipped with portable scales to weigh chosen vehicles on interior routes. The mobile officers have no tools other than their own experience to determine which vehicles might be overweight and pulled over to be weighed using the portable scales. The Virtual Weigh Station (VWS) uses existing fixed weigh-in-motion (WIM) scales along with other in-cabinet and in-vehicle equipment to provide a realtime weight data to officers without leaving their vehicle. The VWS will increase the efficiency of enforcement efforts and help reduce the number of overweight vehicles on Indiana's highways. Note: Full Conference Proceedings available on CD-ROM.
ACCESS: Contact the VDOT Research Library for availability.

Equipment Selection and Site Installation For TLPP SPS WIM Sites
CITATION: Anonymous , Appearing in: North American Travel Monitoring Exhibition and Conference (NATMEC), 2000. Wisconsin Department of Transportation. Pg. 39p.
ABSTRACT: The Long-Term Pavement Performance Program (LTPP) has intensified its efforts to obtain sufficient quantities of research quality loading data at a number of Specific Pavement Studies (SPS) sites. As one part of this effort, the Federal Highway Administration (FHWA) has consulted with the Transportation Research Board LTPP Traffic Expert Task Group for a recommendation for equipment with a significant field history of reliable, low variability, continuous operations. LTPP acknowledges that more than one technology may be capable of achieving the specified performance, however, as with all other LTPP equipment protocols, a single package of sensors, software and pavement performance requirements has been selected as the basis of a set of model specifications. The model specifications are for high-speed bending plate weigh-in-motion (WIM) in a portland cement concrete slab 300 feet long. Installed equipment is expected to meet ASTM E-1318 tolerances for Type I equipment based on axle weights, gross vehicle weights, speeds and axle spacings. A separate smoothness specification has been developed which is partially referenced by incorporation in the grinding criteria for pavements. The details on the verification of scale performance are in a separate document. The specifications are provided as if they were actual contract documents. They are divided into two parts: a hardware and software package, and installation procedures including two options for a portland cement concrete slab. Note: Wisconsin Department of Transportation also produced a CD-ROM with these proceedings.
ACCESS: http://ntl.bts.gov/lib/10000/10900/10981/059ppr.pdf

Error Reduction in Portable, Low-Speed Weigh-In-Motion
CITATION: R. K. Ambercrombie, L. M. Hively, M. B. Scudiere, et al. , 2008. Oak Ridge National Laboratory; Department of Energy. Pg. 8p.
ABSTRACT: This paper will present breakthrough findings based on significant modifications to the Weigh-in-Motion (WIM) Gen II approach, so-called the modified Gen II. The revisions enable slow speed weight measurements at least as precise as in ground static scales, which are certified to 0.1% error. Concomitant software and hardware revisions reflect a philosophical and practical change that enables an order of magnitude improvement in low-speed weighing precision. This error reduction breakthrough is presented within the context of the complete host of commercial and governmental application rationale including the flexibility to extend information and communication technology for future needs.
ACCESS: Contact the VDOT Research Library for availability.

Evaluating Innovative Sensors and Techniques for Measuring Traffic Loads: Final Report
CITATION: Richard Liu, Xuemin Chen, Jing Li, et al. , 2006. University of Houston; Texas Department of Transportation; Federal Highway Administration. Pg. 158p.
ABSTRACT: To evaluate weigh-in-motion (WIM) sensors and techniques for measuring traffic loads, a WIM system standard is introduced. Available WIM sensors in the market such as load cell, bending plate, and piezoelectric sensor, etc. are reviewed. Then a remote WIM system is designed and installed to conduct the evaluation of sensors. The designed system can be accessed remotely and is capable of conducting data acquisition for multiple sensors. With the acquired field data, a pavement deflection load determination algorithm is developed, and the results are compared with the integration algorithm. The analysis shows that pavement deflection can be used for a vehicle's weight measurement. Furthermore, the result is helpful for the nondestructive WIM system design. The Fiber Bragg Grating (FBG) sensor is also evaluated in this research. Compared to piezoelectric sensors, FBG sensors offer a simpler and more explicit load determination algorithm, and the life span of the sensors is longer. However, it is necessary to build a sensor holder for the FBG sensor. In addition to the evaluation of regular WIM sensors, an innovative WIM sensor was developed in this project. It is an active sensor based on the perturbation theory of microwave resonant cavity. The microwave signal generated by a circuit is coupled into the sensor, and the returned signal is measured to determine the

load applied to the sensor. The lab test results show the microwave WIM sensor can weigh the load to very high accuracy. Note: Project title: Evaluating Innovative Sensors and Techniques for Measuring Traffic Loads. Report Date: October 2005; Published Date: October 2006.
ACCESS: http://www.egr.uh.edu/research/files/Final_WIM0-4509.pdf; http://www.egr.uh.edu/research/files/Summary_0-4509-S.pdf

Evaluation Of Weigh-In-Motion For ITS-CVO Applications Using WESTA
CITATION: Derek Trischuk, Curtis Berthelot and BRIAN TAYLOR. , Appearing in: National Research Council (U.S.). Transportation Research Board. Meeting (81st : 2002 : Washington, D.C.). Preprint CD-ROM, 2002. Jamiat al-Imarat al-Arabiyah al-Muttahidah; Partners for Advanced Transit and Highways (PATH); Partners for Advanced Transit and Highways (PATH); University of Minnesota, Twin Cities; University of California, Irvine; Joint Transportation Resear(TRUNCATED). Pg. 21-p.
ABSTRACT: This paper investigates the sorting efficiencies of different types of weigh-in-motion (WIM) systems commonly used for enforcement of commercial vehicle operations (CVO) using a weigh station micro simulation model WESTA. In particular, this study investigates the effect WIM system accuracy has on the effectiveness of pre-sorting commercial vehicles prior to approaching a weigh station. To do this WESTA simulations were performed on a typical commercial weigh station facility with and without mainline WIM across a range of commercial truck volumes (200, 400 and 600 Class 9 trucks per hour) and WIM system accuracies (ASTM Type III and Type I WIM). Three evaluation criterion were used in this study: (1) the number of compliant trucks that were required to report to the station, (2) the number of overweight trucks that were instructed to bypassed the station, and (3) the time the weigh station remained open. This study showed improved weight enforcement efficiency with WIM. The improvements in weight enforcement efficiency translate into considerable savings for both the weight enforcement agency in terms of improved enforcement effectiveness and protection of the infrastructure, and the trucking industry in terms of reduced user delay costs. This study also found that higher WIM system accuracy results in a higher agency and user savings. Note: Publication Date: 2002. Transportation Research Board, Washington DC. Remarks: Paper 02-4184 prepared for presentation at the 81st annual meeting of the Transportation Research Board, Washington, D.C. January 2002. Format: CD ROM.
ACCESS: Contact the VDOT Research Library for availability.

Field Evaluation of Truck Weigh Station Operations
CITATION: Hesham Rakha, Bryan J. Katz and Ahmed Al-Kaisy. , Journal of Intelligent Transportation Systems, 2006. Taylor & Francis. Vol. 10, No. 2, Pg. pp-49-57.
ABSTRACT: Weigh-in-motion (WIM) systems can improve the capacity of weigh-station operations by screening trucks traveling at high speeds and requiring only trucks within a threshold of a maximum permissible weight or axle load to be weighed on more accurate static scales. The efficiency of a weigh station is highly dependent on the accuracy of the WIM screening system. This article examines the operations at the Stephens City weigh station in Virginia. The case study evaluates the accuracy of the WIM technology, in addition to the operations of the weight station, in terms of service time (time that the truck is on static scale), queued delay, and system time. Specifically, the study demonstrated that the WIM system did not conform to American Society for Testing and Materials (ASTM) standards for Type III WIM systems. The study also demonstrated that by incorporating a weight threshold of 96%, only 16% of the trucks that were identified as possible violators actually violated the legal limits. Consequently, 84% of the trucks that were required to enter the static scale were forced to incur unnecessary delays and caused additional delays for violating and nonviolating trucks.
ACCESS: http://www.informaworld.com/10.1080/15472450600626224

Green Light Weigh Station Preclearance Program
CITATION: Anonymous , 2003. Oregon. Dept. of Transportation. Motor Carrier Transportation Division. ABSTRACT: Green Light is's a way for Oregon truckers to save the time and money they waste stopping at weigh stations. It's a truck weigh station

"preclearance" system that's just like systems you'll find in many other states. But the Oregon Green Light system is better than most: it's free! Scales in the roadway weigh trucks in-motion at high speed as they approach the station while automatic vehicle identification devices look for signals from a palm-size transponder mounted inside truck windshields. The transponder contains only a 10-digit number that is used to identify the carrier and specific truck. A computer takes in all the information, verifies truck size and weight, checks the carrier's registration and safety records, and sends a green light signal back to the transponder if the truck is "good to go" past the station. Note: Publication Date: 2003. Remarks: Website viewed May 10, 2003. Format: website.
ACCESS: http://www.odot.state.or.us/trucking/its/green/light.htm

Heavyweight Safety: Overweight Commercial Vehicles Are A Safety Hazard To Other Motorists And Have An Inordinate Impact On Infrastructure
CITATION: BRIAN TAYLOR, Art Bergan, Norm Lindgren, et al. , Traffic technology international : the international review of advanced traffic management.2000, 2000. Great Britain. Defence Research Agency; Digital Image, Inc.; Schwartz Electro-Optics, Inc.; Kistler Instrumente AG; Measurement Specialities, Inc.; International Road Dynamics, Incorporated; Talking Signs, Inc.; Nichia America Corporation; Telis(TRUNCATED). Pg. p.-234-237.
ABSTRACT: This article looks at the need for enforcing commercial vehicle weights and dimensions laws. It discusses how effective weight enforcement, along with a comprehensive data collection program, can be used to create a road asset management framework. The article discusses issues related to the effectiveness of enforcement, the magnitude of overloading, weigh station avoidance, safety and overloading, and the cost of overloading. It maintains that the best weight enforcement program is a combination of fixed and mobile facilities. Note: Publication Date: 2000.
ACCESS: Contact the VDOT Research Library for availability.

Innovative Bridge Weigh-in-Motion System for Bridge Maintenance: A Case Study with Bridge on Highway I-59
CITATION: Hua Zhao, Nasim Uddin, Wilbur A. Hitchcock, et al. , Appearing in: Tenth International Conference on Bridge and Structure Management, Transportation Research E-Circular, 2008. Transportation Research Board. No. E-C128, Pg. pp-369-383.
ABSTRACT: One of the primary causes of bridge failure is overloaded commercial vehicles. In order to prevent deterioration of a bridge it becomes important not only to design and build bridges according to the regulations but also enforce commercial vehicle maximum weight standards. For these reasons, a bridge weigh-in-motion (B-WIM) system should be a key asset in maintaining the balance sought. The B-WIM device placed on the soffit of a bridge includes strain transducers and, usually, separate axle detectors placed on the deck, to determine axle loadings, axle spacing, speed, and gross vehicle weight as a truck moves across the bridge. B-WIM devices have become an important means to better enforcement and better bridge design in many international countries. The objective of this paper is to gather as much information as possible about existing and emerging B-WIM systems in order to determine its potential for implementation in the United States. The information sought includes the benefits of using B-WIM, the steps involved in implementing its technology in the United States, and how to evolve the current systems. The paper summarizes an assessment study that was carried out on an Interstate 59 (I-59) bridge structure in Alabama with a B-WIM (Bridge Weigh-In-Motion) system called SiWIM, developed in Slovenia by ZAG and CESTEL. The main objective of this study was to assess the performances of the system based on the preliminary data, and to acquire experience on its implementation, in order to elaborate technical rules for the choice of bridge types suitable for B-WIM, and how to design their instrumentation. The accuracy classes of the system with respect to the specifications are assessed. The data were analyzed with regard to overloading on axles (single axle or axle group) or gross weight overloading and to calculate what proportion of the loaded vehicles was overloaded, either on axles or relative to the vehicle's gross weight. The effect on the road structure was also analyzed, because dimensioning for the road structure is based on knowledge of the traffic or on an ability to assess the volume of traffic accurately. Moreover, the damaging impact

of an overloaded vehicle may vary, in that the number of standard axle loads per vehicle factor and the incidence of overloading are not covariants. Therefore, measurements were carried out to gain a picture of the make-up of the heavy traffic in terms of loads and the incidence of overloading. By gaining a picture of the make-up of the heavy traffic in terms of loads and the incidence of overloading it is possible to establish a foundation in fact for (a) appropriate actions to achieve better compliance with regulations, (b) planning of road maintenance, and (c) dimensioning the road structure in road building and road maintenance.
ACCESS: http://onlinepubs.trb.org/onlinepubs/circulars/ec128.pdf

Integration of Weigh-in-Motion Technologies in Road Infrastructure Management
CITATION: George Yannis and Constantinos Antoniou. , ITE J., 2005. Institute of Transportation Engineers. Vol. 75, No. 1, Pg. pp-39-43.
ABSTRACT: This article reviews the current weigh-in-motion (WIM) technologies and compares their cost and accuracy. WIM systems allow for the unobtrusive and continuous collection of vehicle weight information, ranging from precise individual weight measurements for each vehicle to aggregate vehicle weight profiles for road sections. The article's objective is to explore the potential applications of available WIM sensor technologies with respect to their technological characteristics. A framework for their integration into the efficient management of road infrastructure is proposed, focusing on design, data requirements, decision support functionality and functional characteristics. The benefits of the integration of WIM applications in appropriate road management information systems are also discussed.
ACCESS: Contact the VDOT Research Library for availability.

The Integration Of Weigh-In-Motion, Automatic Vehicle Identification And Electronic Toll Collection Into Commercial Vehicle Operation
CITATION: Chia-pei Chou, Yi-hsien Chen and I-Chang Chen. , Appearing in: National Research Council (U.S.). Transportation Research Board. Meeting (82nd : 2003 : Washington, D.C.). Compendium of papers CD-ROM, 2003. Partners for Advanced Transit and Highways (PATH); California Department of Transportation; University of California, Berkeley. Dept. of Electrical Engineering and Computer Science. Pg. 22-p.
ABSTRACT: Electronic Toll Collection (ETC) is one of the major developing fields of Intelligent Transportation Systems (ITS) in recent years. The field trial of ETC had been implemented for two years in Taiwan Freeway System. The main components of ETC include Automatic Vehicle Classification (AVC), Automatic Vehicle Identification (AVI) and Video Enforcement System (VES). In addition, Weigh-In-Motion (WIM) has been widely applied and incorporated into Commercial Vehicle Operations (CVO) with Automatic Vehicle Identification (AVI) technologies in Taiwan for more than eight years. This is also considered as a sub field under ITS. With the integration of AVI and WIM technologies, the weight and safety check of commercial vehicles and drivers can been done in real time on highway main lanes under normal traffic speed. Since AVI is the key-bridge between ETC and CVO, the integration will not only significantly increase the total system benefits but also can dramatically improve the effectiveness of commercial vehicle operations and law enforcement. The objectives of this study are to develop the system architecture, build up the system operating mechanism, and carry out the field trial of the prototype system. The prototype system that performs the function of electronic screening of overloaded trucks has been developed and tested on freeway in this study. All overloaded test trucks are identified satisfactorily verifying the technological feasibility of this integrated system.
Note: Publication Date: 2003. Transportation Research Board, Washington DC. Remarks: Paper prepared for presentation at the 82nd annual meeting of the Transportation Research Board, Washington, D.C., January 2003. Format: CD ROM.
ACCESS: Contact the VDOT Research Library for availability.

Load Rating and Permit Vehicle Routing
CITATION: M. Nord and G. Hovey. , Appearing in: Eighth International Bridge Management Conference, Transportation Research Circular, 2000. Transportation Research Board. No. 498, Pg. 11-p.

ABSTRACT: The Colorado Department of Transportation (CDOT), through an agreement with In Motion, Inc., of Denver, Colorado, has developed an automated Windows-based PC system for issuing permits for most of the 100,000+ extra-legal load requests Colorado receives each year. The automated system relies on geographic information system (GIS) information to track the current status of the State's highway network. The system documents pertinent ownership and load information about a truck, checks height, length, and weight restrictions (up to 200,000 lb), determines an appropriate route, identifies special needs such as pilot cars when necessary, and issues a permit to the trucking firm electronically. The system can select a route for the trucker automatically, check a route requested by the trucker, select a "common route" or a route can be selected by "point-and-click" on a map. The system is flexible and is used to issue single trip and annual permits. The system logs all requests and creates an electronic "rolodex" database of requestors, which saves time and eliminates errors for future requests from the same company. Based on predefined axle and axle group criteria, the system is used to permit loads up to 200,000 lb. Permit requests for loads over 200,000 lb are sent to, and reviewed by, engineers in CDOT's Staff Bridge Branch Rating Unit. Over the years, CDOT has developed tools to help expedite analyses and provide faster turn-around to the trucking industry. Some of these tools have been incorporated into the automated system and future enhancements will include more of these tools to aid in evaluation of loads greater than 200,000 lb. This paper describes the automated system, the enhancements to the system currently being worked on, the current method of reviewing overload requests (less than as well as greater than 200,000 lb), and the future automation for loads over 200,000 lb.
ACCESS: http://gulliver.trb.org/publications/circulars/circ498/circular498.pdf

Mechanistic-Based ESALs for Urban Pavements
CITATION: L. Thomas, C. Berthelot and B. TAYLOR. , Appearing in: 2007 Annual Conference and Exhibition of the Transportation Association of Canada: Transportation - An Economic Enabler (Les Transports: Un Levier Economique), 2007. Transportation Association of Canada. Pg. 28-p.
ABSTRACT: Equivalent Single Axle Loads (ESALs) have been the standard traffic loading measure used in highway engineering and pavement management practices for decades. However, there are several significant limitations to the application of conventional ESALs for engineering and managing urban pavements systems under modern field state conditions. The objective of this research was to investigate the use of a typical urban load spectra analysis with weigh-in-motion, as well as falling weight deflection pavement structural response assessment methods, for developing mechanistic-based structural impact load equivalencies that specifically address traffic loading urban field state conditions. This research found that the historic method of estimating pavement design life ESAL's may be highly inaccurate for urban field state conditions. This research found that conventional load equivalencies may be up to 700% low when compared to actual pavement primary responses under modern day urban field state conditions. Given the increasing truck traffic as observed in urban centres across Canada, it is recommended that urban road managers adopt mechanistic-based ESALs to more accurately assess the actual field state loading impacts that may be occurring in the field.
ACCESS: http://www.tac-atc.ca/english/pdf/conf2007/s15/thomas.pdf

A New Method For Accurately Estimating The Weight Of Moving Vehicles Using Piezoelectric Sensors And Adaptive-Footprint Tire Model
CITATION: Sung-Wook Kim, Ilsoo Cho, Joo-Hyung Lee, et al. , Vehicle system dynamics.Vol.39, no.2, 2003. University of California, Berkeley. Dept. of Mechanical Engineering; Partners for Advanced Transit and Highways (PATH); University of Minnesota. Dept. of Mechanical Engineering; Minnesota. Dept. of Transportation; National Science Foundation; So(TRUNCATED). Pg. p.-135-148.
ABSTRACT: In this paper, the authors describe a new method for estimating the axle weight of a moving vehicle. It uses two piezoelectric sensors and an adaptive-footprint tire model. The method is less sensitive to variable factors that influence the axle weight of a moving vehicle. Results from experiments indicate that the developed method, when

compared to two other algorithms, is more consistent and accurate. Note: Publication Date: February 2003.
ACCESS: Contact the VDOT Research Library for availability.

Numerical Characterization of Gross Vehicle Weight Distributions from Weigh-in-Motion Data
CITATION: Andrew P. Nichols and Mecit Cetin. , Transportation Research Record: Journal of the Transportation Research Board, 2007. Transportation Research Board. No. 1993, Pg. pp-148-154.
ABSTRACT: This paper presents a method for quantifying gross vehicle weight (GVW) distributions of commercial vehicles using weigh-in-motion (WIM) data. Finite mixture models are used to fit a combination of normal distributions to the overall GVW distribution to identify peak parameters more precisely. The GVW distribution is commonly bimodal or trimodal with prominent peaks occurring in the loaded and unloaded weight ranges. The GVW characteristics of FHWA Class 9 vehicles are commonly used for assessing WIM accuracy by visual interpretation of frequency histograms. Temporal changes in the GVW distribution are difficult to detect using common visualization techniques. Mixture models enable the statistical identification of the modal peaks and the proportion of traffic belonging to those peaks for ongoing monitoring purposes. Mixture models are applied to a WIM site in Indiana to illustrate the analysis method and benefits. Numerical monitoring of the GVW distribution is shown to have some advantages over the widely accepted metric based on the Class 9 steer axle weight. The proposed metric should not be used singularly, rather as an additional tool to complement existing metrics.
ACCESS: http://dx.doi.org/10.3141/1993-20

On Dynamic Weighing Of Highway Vehicles In Motion
CITATION: T. Ono. , Appearing in: SICE 2003 Annual Conference, 2003. Institute of Electrical and Electronics Engineers. Pg. p.-2108-15.
ABSTRACT: A brief review of the methods for dynamic weighing of highway vehicles in motion is provided in this tutorial. Also presented is an recent investigation both on the new method to improve the accuracy of the estimated axle loads and of the estimated total weight and on the uncertainty evaluation for dynamic weighing, invoking the concept of grey estimation.
ACCESS: Contact the VDOT Research Library for availability.

Optimization And Implementation Of Fiber Optic Sensors For Traffic Classification And Weigh-In-Motion Systems (Phase 3)
CITATION: P. J. Cosentino and B. G. Grossman. , 2000. Florida Institute of Technology, Melbourne; Florida Department of Transportation. Pg. 221-p.
ABSTRACT: This research included laboratory and field testing that enabled optimizing and implementing fiber optic traffic classification and weigh-in-motion (WIM) sensors. Nearly 50 fiber-optic microbend sensors were placed in 5 field sites in Brevard County, Florida. Four of the sites were flexible pavements and the fifth was a rigid pavement. Sensors were 6 ft long and had fiber optic leads. They were encapsulated with relatively soft materials that were not temperature dependent. Sensors were successfully placed in both horizontal and vertical orientations. Two of the sites are Florida Department of Transportation (FDOT) telemetry sites used for vehicle classification, where sensors installed in December 1998 and September 1999 have been functioning under normal traffic conditions. Sensors installed in the access roads of two local plants with heavy truck traffic were used for signal evaluation. Falling weight deflectometer tests were conducted on sensors installed in the rigid and flexible plant access roads to evaluate the accuracy of the fiber-optic sensor signals for WIM applications. Sensors were installed using two geometries, two encapsulation materials in the two pavements. Of the variables investigated, the interaction between the encapsulated material and the sensor orientation had the greatest effect on fiber optic traffic sensor signal. Several laboratory sensor characterization tests have been developed. These tests were designed to produce data on the behavior under static and pneumatic loading conditions similar to those encountered in the pavement. Data were obtained on the load versus sensor light loss under both static and pneumatic

loads. Data were also obtained on the load versus deflection versus light loss under pneumatic loads. The load-deflection-light loss data were input into several finite element models that were used to study the sensor pavement interaction. According to these models when the sensors are placed in vertical grooves they have an optimal placement zone near the surface. Scanning electron microscope photographs were taken of segments of the fiber-optic traffic sensors as the load varied. The microbend contact stresses were analyzed using Hertz' equation for the contact stresses between two cylindrical bodies. It was concluded that the fiber used for the sensor would fail at a compressive load of approximately 700 kPa (100 psi) and that Hertz' equation could be used to predict the length of the elliptical failure contact area. These fiber optic traffic sensors are ready for implementation into traffic classification systems. The sensors are immune to electromagnetic interference, corrosion resistant and reliable. The installation procedure is simple, with the groove requiring only a masonry blade in a standard saw for cutting.
ACCESS: Contact the VDOT Research Library for availability.

Piezo: Data on a WIM
CITATION: Don Halvorsen. , Traffic Technology International, 2007. AutoIntermediates Limited. Vol. 2007, No. 8, Pg. pp-76-77.
ABSTRACT: This article describes the use of piezoelectric sensors for applications in weigh in motion (WIM) truck tolling. Data collection and monitoring is the most important component of WIM tolling, which is in turn essential for the FHWA Long Term Pavement Performance (LTPP) program. In the United Kingdom, WIM systems work by monitoring truck weight by axle. If it is found that if any one axle exceeds the weight limit, a photograph is taken by an automated camera and the truck is the fined. Piezoelectric sensors work by converting the vehicle load weight on the ground above into an electrical signal, which is then processed by algorithms into a weight datum. The sensors can be installed through a 20 mm wide slot in the road with a depth of 10 to 75 mm. Other factors relating to the implementation and efficacy of these sensors are also discussed.
ACCESS: Contact the VDOT Research Library for availability.

Post-proceedings of the Third International Conference on Weigh-In-Motion (ICWIM3), May 13-15, 2002, Orlando, Florida, USA
CITATION: Anonymous , 2003. Iowa State University Center for Transportation Research and Education. Pg. 1-CD-ROM.
Note: International Conference on Weigh-in-Motion ICWIM3 System requirements: PC or compatible; Adobe Reader; CD-ROM drive. Papers in English; abstracts in English, French and Spanish. Title from navigation screen. Held in conjunction with the North American Travel Monitoring Exhibition and Conference.
ACCESS: Contact the VDOT Research Library for availability.

Probabilistic Assessment of Bridge Loading Concurrent with Permit Vehicles
CITATION: Kurt Gurley and Scott Washburn. , 2005. University of Florida, Gainesville; Florida Department of Transportation; Federal Highway Administration. Pg. 124p.
ABSTRACT: The presence of a single permit vehicle on a bridge in addition to the loads from standard weight vehicles is arguably accounted for implicitly in the multi-presence factors in the American Association of State Highway and Transportation Officials (AASHTO) code. However, the presence of multiple permit vehicles may conceivably exceed the capacity of the bridge. This study provides guidance for determining the loads that should be considered concurrent for the purpose of calculating appropriate bridge operating ratings. The study presents a statistical analysis of permit vehicles (vehicles that exceed 80,000 lb) traveling in close proximity to each other over bridges within the State of Florida. The objective is to find the likelihood of exceeding various combined weights of concurrent permit vehicles on a bridge. The sources of data for this study are the weigh in motion (WIM) records from 37 WIM stations in Florida, collected between January 1998 and August 2003. The study presents results from the four most heavily traveled WIM stations. A concurrent permit vehicle occurrence is defined as two or more permit vehicles that are within close enough proximity to each other as to span a total distance no longer than the average length of all bridges within a 15-mi radius of the given WIM station. In

this manner, the probability of concurrent vehicles exceeding various weight thresholds is extrapolated from the actual measurement location (WIM station) to those bridges within 15 mi of the station and along the same route. It is shown that, within any given month, there is a high probability of more than one permit vehicle concurrently crossing bridges along major traffic routes. Further, there is an appreciable likelihood that the combined weight of these concurrent permit vehicles will exceed 250,000 lbs within any given month. The specific probabilities are quantified within the report for the four WIM stations analyzed.
ACCESS: Contact the VDOT Research Library for availability.

Remotely-Operated Compliance Stations for Commercial Vehicles
CITATION: Amr A. Oloufa, Engy Serag, Tarek Shaalan, et al. , Appearing in: 12th World Congress on Intelligent Transport Systems, 2005. ITS America. Pg. 13p.
ABSTRACT: Weigh-In-Motion is considered a tool for weight enforcement and data collection. The adoption of modern Weigh-in-Motion systems have allowed trucks to avoid stopping at static scales in Weigh Stations leading to large benefits for interstate commerce and the reduction of pollution. This paper reports on research aimed at developing and testing a remote compliance station in Florida aiming to provide a better functionality by operating it remotely through sensors located at areas where bypass roads are used by some commercial vehicles to avoid weigh stations all together. The research project also includes the deployment of a web-based public database to serve as a reference for available technologies, vendors, and evaluation results.
ACCESS: Contact the VDOT Research Library for availability.

Sampling Schemes for Weigh-in-Motion Traffic Data Collection
CITATION: Feng Hong, Jorge A. Prozzi and Arthur Leung. , Transportation Research Record: Journal of the Transportation Research Board, 2008. Transportation Research Board. No. 2049, Pg. pp-38-44.
ABSTRACT: Weigh-in-motion (WIM) technology has been widely used in highway traffic monitoring to support design and reconstruction of pavement structures. WIM systems are capable of continuously collecting vehicle size and weight data. However, collecting, storing, and processing the large amount of data required is costly. The cost is a critical concern of many state highway agencies (SHAs) because of their budget limitations and resource constraints. To address this issue, adopting sampled data instead of complete or population data has been recommended in most SHAs. However, it has been recognized that a gap inevitably exists between data samples and population. Therefore, a balance between data needs in pavement design and cost in data supply should be obtained. The effect of different sampling schemes on data accuracy on the basis of traffic information collected by WIM systems in Texas was comprehensively investigated. Three criteria involving both mathematical implication and engineering context were developed for evaluation of sampled data accuracy. A relationship between typical sampling schemes and data accuracy was established. The results and suggestions can provide more cost-effective and efficient WIM data collection for SHAs.
ACCESS: http://dx.doi.org/10.3141/2049-05

Scales In Motion
CITATION: JOHN GALLAGHER. , Traffic World, 2002. Commonwealth Business Media.
ABSTRACT: Subtitle: Sensor Manufacturer Says Its Product Will Be Able To Address Weigh-In-Motion For The Rail Industry. Note: TRAFFIC WORLD, V. 266, NO. 31 (AUG. 5, 2002), P. 22: ILL.
ACCESS: Contact the VDOT Research Library for availability.

Spatial Awareness: Too High, Too Wide or Too Long?
CITATION: Kurt Amstad. , Traffic Technology International, 2008. AutoIntermediates Limited. Pg. pp-92-93.
ABSTRACT: This article describes a non-contact measuring system that was developed to help enforce the height, width, and length limits of vehicle dimensions. The system uses three lasers to survey vehicles as they drive under two gantries. The article details the

scanning process and how the measurements for height, width, and length are achieved. Once the data has been obtained, the calculated profile is used to automatically classify the vehicle and compare the results with maximum values and tolerance values. A 3D model is also generated, highlighting any areas where problems or discrepancies are present.
ACCESS: Contact the VDOT Research Library for availability.

Strategies for Successful Implementation of Virtual Weigh and Compliance Systems in California
CITATION: Amelia Regan, Minyoung Park, Srinivas Nandiraju, et al. , PATH Research Report, 2006. Partners for Advanced Transit and Highways (PATH); University of California, Irvine; California Department of Transportation; California PATH. Pg. 57p.
ABSTRACT: This study documents recent efforts and technologies related to the automated monitoring and enforcement of commercial vehicles. It presents the current state of the practice in using advanced weigh in motion (WIM) to deal with overweight vehicle enforcement. The study first describe s the historical background and current of commercial vehicle enforcement practices. Emerging new technologies and methods applicable o upgrading existing commercial vehicle weight enforcement methods are next discussed. The study looks at the basic concept of the virtual weigh and compliance system (VWCS) considered by the California Department of Transportation (Caltrans). Key considerations when implementing the VWCS are discussed. The study concludes with recommended strategies for successful implement of the VWCS.
ACCESS: http://www.path.berkeley.edu/PATH/Publications/PDF/PRR/2006/PRR-2006-19.pdf

Summary Of U.S. National And Regional Trends In Truck Loading
CITATION: D. Jones. , Appearing in: Third International Conference on Weigh-in-Motion (ICWIM3), 2002. Iowa State University, Ames; Federal Highway Administration; Florida Department of Transportation; Center for Transportation Research and Education. Pg. p.-277-280.
ABSTRACT: This presentation summarizes national and regional trends in truck loading in the United States on the Interstate System from 1990 to 2000. The data are from the Truck Weight Study which consists of vehicle classification and weigh-in-motion (WIM) data submitted by State highway agencies. The Vehicle Travel Information System (VTRIS) is used to process the data. Daily traffic and loadings are summarized and compared by year and by region.
ACCESS: Contact the VDOT Research Library for availability.

System and Method for Identifying, Validating, Weighing and Characterizing Moving or Stationary Vehicles and Cargo
CITATION: D. L. Beshears, S. G. Batsell, R. K. Abercrombie, et al. , 2004. UT-Battelle; Department of Energy. Pg. 18p.
ABSTRACT: An asset identification and information infrastructure management (AI3M) device having an automated identification technology system (AIT), a Transportation Coordinators' Automated Information for Movements System II (TC-AIMS II), a weigh-in-motion system (WIM-II), and an Automated Air Load Planning system (AALPS) all in electronic communication for measuring and calculating actual asset characteristics, either statically or in-motion, and further calculating an actual load plan are discussed.
ACCESS: Contact the VDOT Research Library for availability.

Test of WIM Sensors And Systems On An Urban Road
CITATION: Markus Caprez, Emil Doupal, Bernard Jacob, et al. , International Journal of Heavy Vehicle Systems, 2000. Inderscience Enterprises Limited; International Association for Vehicle Design/Inder Sciences Enterprises Limited. Vol. 7, No. 2, Pg. p.-169-190.
ABSTRACT: This paper describes a large-scale test of six weigh in motion (WIM) systems and four additional sensors on an urban roadway in Zurich, Switzerland. Gross weights from thousands of statically weighed vehicles were used to determine the levels of accuracy for each system, with reference to the new draft of the European specification on

WIM (COST323). The accuracy of axle weights was not tested. The WIM sensors, which included one prototype, were tested with the assistance of a recording and processing device supplied by the organiser. Most systems encountered some problems, failures and faults, under the carefully controlled conditions of the 30-month test. However, these were generally solved by the suppliers after some delay. Statistics are provided showing overall levels of accuracy and trends with season and time. Additionally, a brief history of system malfunctions and failures is provided. Nevertheless the scope of the conclusions is limited by the traffic conditions and the test plan.
ACCESS: Contact the VDOT Research Library for availability.

Truck Travel Time Around Weigh Stations: Effects Of Weigh In Motion And Automatic Vehicle Identification Systems
CITATION: R. F. Benekohal, Y. M. El-Zohairy and S. Wang. , Transportation Research Record, , 2000. Transportation Research Board. No. 1716, Pg. p.-135-143.
ABSTRACT: Weigh in motion (WIM) technology may provide an efficient and cost-effective complement to static weighing. An evaluation of the effectiveness of an automated bypass system around a weigh station in Illinois is presented. The system combines the use of automatic vehicle identification (AVI), high-speed weigh in motion (HSWIM), and low-speed weigh in motion (LSWIM) technologies to facilitate preclearance for trucks at the weigh station. The preinstallation conditions were compared with postinstallation conditions of WIM/AVI so that the effects and benefits of the system could be evaluated. During preinstallation, average delay was 4.9 min/truck, and 7% of trucks had delays of more than 10 min. The station was intermittently closed to prevent the truck queue from backing up onto the Interstate highway, allowing 15 to 51% of trucks to bypass the station without being weighed. In postinstallation, the delay for trucks equipped with transponder and allowed to bypass on the freeway was reduced by 4.17 min. The delay for trucks equipped with transponders and allowed to bypass inside the weigh station was reduced by 2.02 min. The delay for trucks that reported to the weigh station decreased by 1.25 min. On the other hand, less than 1% of trucks that have been observed in after-study were able to bypass on the freeway. With greater numbers of trucks being checked, fewer trucks on the road may exceed the allowable weight limits. Consequently, electronic screening minimizes road deterioration and risks to public safety and levels the playing field for illegally operating carriers and carriers who operate in compliance with the law.
Note: This paper appears in Transportation Research Record No. 1716, Pavement Assessment and Testing.
ACCESS: http://dx.doi.org/10.3141/1716-16

Use of WIM Sites For Commercial Vehicle Enforcement
CITATION: Anonymous , Appearing in: North American Travel Monitoring Exhibition and Conference (NATMEC), 2000. Wisconsin Department of Transportation. Pg. 3p.
ABSTRACT: The Wisconsin Department of Transportation (DOT) has a long history of using weigh in motion (WIM) technology for planning purposes when designing roadways. Data is collected at various Strategic Highway Research Project (SHRP) sites throughout the state. WIM technology is also used within the DOT by the Division of State Patrol for weight enforcement of commercial motor vehicles. Four of their Safety and Weight Enforcement Facilities are equipped with WIM technology for commercial vehicle enforcement. Over the last several years the Division of State Patrol has been researching the feasibility of using the SHRP sites as a screening tool for commercial vehicle enforcement. To date, the Planning Section of the Department has been reluctant to allow shared use of these sites. They feel that if enforcement is using these sites, word would get out among carriers and they would avoid or divert from these locations. This would then result in the data collected from these sites being corrupted (i.e., not showing an accurate sampling of what is actually occurring on the roadways). There are agencies across the United States which have found ways of sharing the technology and data generated from SHRP sites. For example, Michigan has demonstrated how planning and enforcement can effectively use the same resources for varied purposes. They have experienced successful enforcement results without adverse effects on the data collected for planning. In light of financial and personnel constraints facing agencies today, it is

important to search for innovative ways to pool available resources in order to achieve desired results. States must look beyond the traditional methods of operation in order to maximize success. Note: Wisconsin Department of Transportation also produced a CD-ROM with these proceedings.
ACCESS: http://ntl.bts.gov/lib/10000/10000/10041/124ppr.pdf

Using Weigh-In-Motion Data in a Modern Truck Traffic Information System
CITATION: A. Clayton, J. Montufar and D. Middleton. , Appearing in: Third International Conference on Weigh-in-Motion (ICWIM3), 2002. Iowa State University, Ames; Federal Highway Administration; Florida Department of Transportation; Center for Transportation Research and Education. Pg. p.-353-362.
ABSTRACT: The paper reports on the on-going design, development and implementation of a new truck traffic information system for the Province of Manitoba, Canada. The system will integrate data and information from six different sources: a greatly expanded automatic vehicle classifier (AVC) and weigh-in-motion- (WIM-) based truck traffic monitoring network; an automated static weight data collection; expert knowledge about trucking; freight traffic databases; special truck traffic survey (CCMTA Roadside Survey) and the new Statistics Canada Vehicle Inventory and Use Survey (VIUS); and border crossing statistics. Both the New Traffic Monitoring Guide and the AASHTO 2002 Pavement Design Guide are being used to guide system design details.
ACCESS: Contact the VDOT Research Library for availability.

Using WIM and FWD Data To Evaluate The Impact Of Load Restrictions On Pavements
CITATION: F. Prophete and D. St-Laurent. , Appearing in: Third International Conference on Weigh-in-Motion (ICWIM3), 2002. Iowa State University, Ames; Federal Highway Administration; Florida Department of Transportation; Center for Transportation Research and Education. Pg. p.-305-314.
ABSTRACT: This article describes a system that uses data gathered from weigh-in-motion (WIM) stations to evaluate the equivalent single axle loads (ESALS) applied to pavements by heavy vehicles. One of the main results obtained is a general model of ESAL reduction during thaw periods. The model is used to simulate various axle weight restricting scenarios and to evaluate their effectiveness in ensuring adequate protection of the road network. The impact of the restriction scenarios on pavements is then determined by combining the heavy traffic loading models with the pavement damage models derived from falling weight deflectometer (FWD) testing.
ACCESS: Contact the VDOT Research Library for availability.

Virtual Weigh Stations in California: A Preliminary Cost-Effectiveness Analysis
CITATION: Nicholas Santero, Willilam Nokes and John Harvey. , PATH Working Paper, 2005. University of California, Berkeley; California Department of Transportation; Partners for Advanced Transit and Highways (PATH); California PATH. ABSTRACT: Virtual Weigh Station (VWS) technology is intended to transform data-collecting weigh-in-motion (WIM) sites to weight enforcement mechanisms. In this study, the authors investigate the possible benefits to highway pavements in California from the potential use of VWS. The investigation focused on first determining the damage currently caused by overweight trucks in California. This was followed by the modeling of potential pavement life saved with VWS. The data used in the analysis is from the California Department of Transportation (Caltrans) WIM database.
ACCESS: http://www.path.berkeley.edu/PATH/Publications/PDF/PWP/2005/PWP-2005-05.pdf

Weigh To Go : Weighbridges Are A Crucial Weapon In The Battle Against Road Damage Caused By Overloaded Vehicles
CITATION: R. Stokes. , Traffic Technology International, 2005. UK & International Press; AutoIntermediates Limited. Pg. pp-54-55.
ABSTRACT: This article describes weigh in motion (WIM) system for determining the weight of trucks without requiring the time-consuming positioning of the truck on scales.

The system can accommodate all sizes of trucks and future requirements. While the vehicle is being weighed, the system also captures the driver, vehicle, operator and load details and transmits the information to a central processing unit where invoices are generated. The article also describes how the same technology has been incorporated into portable WIM systems that work from internal rechargeable batteries and can be easily moved. Note: August/September 2005.
ACCESS: Contact the VDOT Research Library for availability.

Weighing the Options
CITATION: Mike Woof. , World Highways/Routes du Monde, 2005. Route One Publishing Limited. Vol. 14, No. 8, Pg. pp-63-64, 66.
ABSTRACT: Overloaded trucks cause rapid wear to road surfaces and sub-bases, as well as structural damage to bridges. The frequency of overloaded vehicles can be reduced through the use of advanced weigh-in-motion systems. This article describes the features of these weigh-in-motion systems and discusses the international market for such technology. A typical system quickly collects driver and vehicle data as well as product description, loading point and weight information through a vehicle detection and identification package. Portable weigh-in-motion systems are also a popular option. Although advanced weigh-in-motion systems are common in the UK, the market is rapidly expanding to South East Asia, Latin, America, Africa and the Middle East.
ACCESS: Contact the VDOT Research Library for availability.

Weighing Up The Cost
CITATION: Anonymous , World Highways/Routes du Monde, 2002. Route One Publishing Limited. Vol. 11, No. 8, Pg. 3-p.
ABSTRACT: This article describes some new systems for gathering traffic data. Weigh-in-motion (WIM) systems can be used to measure the axle loads of a vehicle traveling at highway speed. WIM equipment provides information on wheel and axle loads, gross vehicle mass, axle spacing, vehicle speed, distribution of traffic movement through the day, headway between vehicles, freight movement and traffic volumes and mix. This data can be used for a range of applications, including identifying overloaded vehicles, collecting weight dependent tolls, verifying optimal load distribution, and providing inputs into pavement management systems. WIM systems usually use axle sensors to detect and classify vehicles. One system combines safety information with a WIM size and weight screening system to allow for complete electronic screening of compliance and safe carrier status. Another system measures weight, height and speed of a truck traveling at highway speed, and uses this information to warn a driver of unsafe conditions in order to prevent a truck rollover accident. Note: Page range: pp 63-64, 66.
ACCESS: Contact the VDOT Research Library for availability.

Weigh-In-Motion Applications For Intelligent Transportation Systems--Commercial Vehicle Operations: Evaluation Using WESTA
CITATION: D. Trischuk, C. Berthelot and B. TAYLOR. , Transportation Research Record, , 2002. Transportation Research Board. No. 1816, Pg. p.-87-95.
ABSTRACT: An investigation was undertaken to sort the efficiencies of different types of weigh-in-motion (WIM) systems commonly used for enforcement of commercial vehicle operations. Weigh station microsimulation model WESTA (WEigh STAtion) was used. The investigation focused, in particular, on the effect WIM system accuracy has on the effectiveness of presorting commercial vehicles before they approach a weigh station. WESTA simulations were performed, with and without main-line WIM, on a typical commercial weigh station facility across a range of commercial truck volumes (200, 400, and 600 Class 9 trucks per hour) and WIM system accuracies (ASTM Type III and Type I WIM). Three evaluation criteria were used: (a) number of compliant trucks required to report to the station, (b) number of overweight trucks instructed to bypass the station, and (c) time the weigh station remained open. It was found that weight enforcement efficiency improved with WIM. The improvements in efficiency translate into considerable savings for both the weight enforcement agency in relation to improved enforcement effectiveness and protection of the infrastructure and for the trucking industry in relation

to reduced user-delay costs. It was also found that higher WIM system accuracy results in higher agency and user savings. Note: This paper appears in Transportation Research Record No. 1816, Pavement Management, Monitoring, and Accelerated Testing 2002.
ACCESS: http://dx.doi.org/10.3141/1816-10

Weigh-In-Motion Technology For Military Operations: Developing A Portable, Safe, And Accurate System
CITATION: J. E. Coats, R. K. Abercrombie, D. L. Beshears, et al. , TR News, 2004. Transportation Research Board. No. 231, Pg. p.-16-18.
ABSTRACT: U.S. military forces today are deployed globally and rapidly, often in areas with little infrastructure. Weighing vehicles and other cargo before loading them onto aircraft in a theater of operations is critical to this deployment. Each location requires specifically recalculating the cargo's weight and center of balance and taking into account the effects of altitude, temperature, runway length, and aircraft type. The current process for accomplishing this, when an in-ground fixed weigh scale is not available, is time-consuming, exhausting, and prone to error, especially in adverse weather. In the early 1990s, the U.S. Air Force commissioned the Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee, to develop a portable weigh-in-motion (WIM) system for military deployment. The WIM system improves the weighing process by reducing personnel hours and the time required for deployment and by eliminating opportunities for human errors from the manual transfer of data or from the miscalculation of vehicle attributes. The ORNL is currently enhancing the portable WIM system with a new algorithm for accuracy of weighing, along with upgraded electronics, modifications for field use, interfaces to the databases for military deployment, and a capability to identify automatically the vehicle or cargo being weighed. The system can go anywhere via aircraft and be set up (by two soldiers) and operating in a few minutes. The WIM system may also have applicability in response to the National Transportation Safety Board's February 2004 recommendation that federal regulators and airlines develop methods to weigh passengers and baggage to prevent overloading of airplanes.
ACCESS: http://gulliver.trb.org/publications/trnews/trnews231.pdf

Weight of Intellect: Used for Vehicle Weighing Applications for Years
CITATION: David Cornu, Anwar Awan, Ijaz Ahmed, et al. , Traffic Technology International, 2006. AutoIntermediates Limited. Pg. pp-110-111.
ABSTRACT: This article describes the use of integrated Kistler Lineas quartz weight detectors embedded in asphalt in weigh-in-motion (WIM) systems. The need for WIM systems is obvious for proper maintenance of roadways. The article reports that a 10 percent overloading damages the road surface 40 percent more than approved load weights. Such systems allow for a number of measurements about vehicles, such as number of axles, length of vehicles, class, speed, and direction of motion. The software that operates these machines is also discussed. Using a PC-based package, the quartz sensors are interfaced with the computer software, loop detectors, and camera apparatus, with the computer archiving and processing all relevant information. The article also describes a second layer of software that is for remote sophisticated processing of WIM-related data.
ACCESS: Contact the VDOT Research Library for availability.

Weight Of Numbers : Persistent, Deliberate Commercial Vehicle Overloading Is Costing The American Tax-Payer Money
CITATION: Debra Lowry. , Traffic Technology International, 2002. Loughborough University of Technology. Transport Technology Ergonomics Centre; Partners for Advanced Transit and Highways (PATH); Illinois Department of Transportation; CSI Wireless Inc.; Saab ITS Pty Ltd.; Cornet Technology, Inc.; ERTICO (Organ(TRUNCATED). Pg. p.-34-35.
ABSTRACT: This article describes efforts taking place in the state of Indiana in providing a high tech approach to curbing overweight vehicles on highways. A Virtual Weigh in Motion (WIM) sensor is used to interface with a roadside controller, allowing state troopers to monitor specific sensor sites and capture violates as the violations occur. The information can also be studied to determine times and places where overweight vehicles are

prevalent, thus allowing troopers to heighten patrols at these Virtual WIM locations. Note: Publication Date: June/July 2002.
ACCESS: Contact the VDOT Research Library for availability.

A Weight Off The Mind : Weigh-In-Motion Sensors Do More Than Catch Illegal Operators On The Hop
CITATION: Donald Halvorsen. , Traffic technology international : the international review of advanced traffic management.2000, 2000. Great Britain. Defence Research Agency; Digital Image, Inc.; Schwartz Electro-Optics, Inc.; Kistler Instrumente AG; Measurement Specialities, Inc.; International Road Dynamics, Incorporated; Talking Signs, Inc.; Nichia America Corporation; Telis(TRUNCATED). Pg. p.-230-232.
ABSTRACT: This article looks at how weigh in motion (WIM) data has a variety of applications. The data is primarily used in monitoring activities for the purpose of identifying overweight trucks. It can be also used to evaluate pavement performance and design roads based upon the correct construction method. Note: Publication Date: 2000.
ACCESS: Contact the VDOT Research Library for availability.

A Weight on Your Mind: Intelligent Overload Enforcement
CITATION: Bill Holdsworth. , Traffic Technology International, 2006. AutoIntermediates Limited. Pg. pp-52-53, 55,57-58.
ABSTRACT: In this article, the author discusses the necessity and proper means of enforcement for commercial vehicle overloading, which causes eight times more damage in an accident than a properly loaded vehicle. High-speed weighing systems, or weigh-in-motion (WIM) systems, can be used for monitoring such overloading using piezo or quartz sensors embedded in the road surface. A concern for trucking agencies is that their weight load is maximized without exceeding their limits, as this will, aside from endangering other motorists, incur costs from penalties. Many U.S. WIM systems are in need of improvement as a UK-based observation noted that U.S. systems have accuracies that are 5-20 percent dependent on road conditions, and these are naturally highly variable in different regions. The article closes with a brief prediction of the future of WIM technologies.
ACCESS: Contact the VDOT Research Library for availability.

Weight Watchers: The Role of Weigh-In Motion Systems is of Increasing Importance in Road and Highway Management
CITATION: Brian Taylor and Tom Der. , Traffic Technology International, 2006. AutoIntermediates Limited. Pg. pp-106-107.
ABSTRACT: In this article, the authors describe the role of weigh-in-motion (WIM) technologies in detecting and minimizing the damage caused by overloaded trucks on road surfaces. In order for a management plan of a road to be efficacious, operators must make decisions and policies based in the science of pavements and rational regulation of the roadway. WIM data is useful in this regard as it allows operators to deduce traffic growth, loading trends, pavement performance, better maintenance strategies, and compliance with existing regulations. WIM can also be used in deducing pricing structures given the above information, and has the potential to greatly expedite tolling plaza procedures. Both China and Korea have already implemented such systems, and apply variable tolling rates based on weight correspondingly.
ACCESS: Contact the VDOT Research Library for availability.

Weights and Measures
CITATION: Richard Stokes. , ITS International, 2007. Route One Publishing Limited. Vol. 13, No. 1, Pg. pp-50-51.
ABSTRACT: Overloaded heavy goods vehicles, particularly common in developing countries, not only create safety hazards and cause damage to road infrastructure, but also deplete financial resources that could be better used in other sectors of these countries' economies. This article looks at efforts in Pakistan to help mitigate the impact that overloaded trucks are having on roads and the economy. Despite objections from the domestic trucking industry and persistent flaunting of enforcement programs by drivers, the National Highways Authority is implementing high speed weigh in motion (WIM)

systems to establish accurate levels of loading and enforce regulations. The article also looks at overloading issues in the United Arab Emirates, where aggressive work schedules and economic imperatives make overloading an everyday occurrence. Involvement by outside agencies such as the World Bank, as well as local governments, in funding and implementing weighing programs are discussed.
ACCESS: Contact the VDOT Research Library for availability.

A Weighty Problem Solved
CITATION: Anonymous , World Highways/Routes du Monde, 2001. Route One Publishing Limited. Vol. 10, No. 8, Pg. p.-70-71.
ABSTRACT: A virtual weigh station has been developed to allow enforcement agencies to optimize resources and improve efficiency in identifying overweight trucks. The virtual weigh station uses a weigh-in-motion (WIM) data collection site to detect overloaded trucks. When an overloaded truck is detected, a patrol car is automatically alerted. The officer can then stop the suspected overweight truck to perform a further inspection. The virtual weigh station can be located between permanent truck inspection stations or on known bypass or secondary highways. A remote control truck weigh station system has also been introduced to increase the operating efficiency of enforcement at remote, low volume locations while decreasing operating costs. Remote control weigh stations are monitored from a central location on a random and intermittent basis. Internet-based communication is used to control and operate the weigh stations. This weigh station technology can protect the infrastructure by reducing the incentive for overweight trucks to travel on secondary highways in an attempt to bypass truck inspection stations.
ACCESS: Contact the VDOT Research Library for availability.

WIM or Lose: The Ideal Tools for Damage Limitation- And Much More
CITATION: Saul Wordsworth. , Traffic Technology International, 2007. AutoIntermediates Limited. Vol. 2007, No. 8, Pg. pp-40-41, 43-45.
ABSTRACT: In this article the author advocates for the use of weigh-in-motion technology (WIM) for the monitoring of commercial truck weights. Systems that aim for a higher percentage of trucks that are compliant with the municipality's weight regulations are likely to have a better handle on maintenance costs for that roadway. The Greenlight program being implemented in Oregon offers WIM transponders for free to drivers. Drivers passing through the designated weigh zones with a properly weighed truck and a working transponder will have a green light displayed to them indicating that stopping will not be necessary. This program has 40,000 trucks enrolled and cost $20 million to initiate in 1995. Using hydraulic load cells, trucks are weighed without the lengthy stops that are sometimes required using other systems. WIM systems in California, which use bending-plate technology, and Western Australia are also described.
ACCESS: Contact the VDOT Research Library for availability.

'WIM-Hand', The Development Of A Weigh-In-Motion System For Automatic Enforcement Of Overloading
CITATION: F. J. van Loo. , Appearing in: 8th World Congress on Intelligent Transport Systems, 2001. ITS America. Pg. 8p.
ABSTRACT: National and international goods transportation by road is an important part of the Dutch economy; 173,000 trucks transport 600 million tons annually. Truck traffic in particular is damaging the infrastructure. The number and the loads of (axles of) trucks are the major determinant for the degree of maintenance. A disproportionately large percentage of the damage to the infrastructure is caused by trucks with axle loads higher than the legal maximums. In addition, overloading of one or more axles of a truck or the whole vehicle is likely to have a negative effect on traffic safety. The objective of the 'WIM-Hand' project, discussed in this paper, is to develop a High-Speed Multiple-Sensor Weigh-In-Motion-system that in the future can be used for automatic enforcement of overloading. Note: Full conference proceedings available on CD-ROM.
ACCESS: Contact the VDOT Research Library for availability.

A WIN-WIM Situation: A Good WIM System Can Play An Important Role In Improving The Effectiveness Of Weight Enforcement In The Urban Environment.
CITATION: BRIAN TAYLOR and ROB BUSHMAN. , Traffic Technology International, 2004. UK and International Press; AutoIntermediates Limited. Pg. P.-20-[22].
ABSTRACT: No abstract provided. Note: Traffic Technology International. (June/July 2004), P. 20-[22].
ACCESS: Contact the VDOT Research Library for availability.