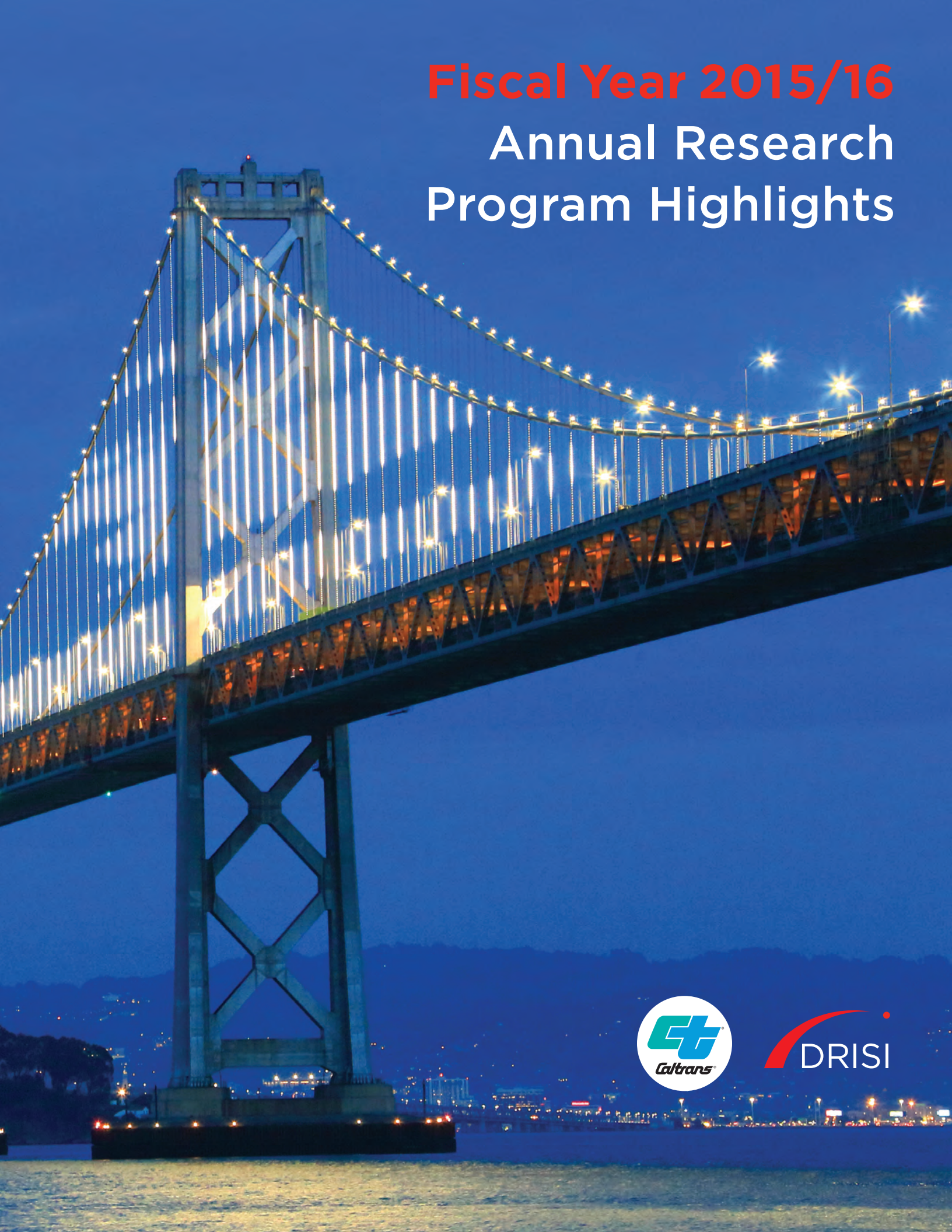
Fiscal Year 2015/16
Annual Research Program Highlights



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Caltrans Division of Research, Innovation and System Information
PO Box 942873
Sacramento, CA 94273-0001
916-654-8899 Voice
711 TTY

Caltrans Research Program

Fiscal Year 2015/16

Annual Research Program Highlights

Caltrans

DRISI

For more information:

California Department of Transportation
www.dot.ca.gov

Division of Research, Innovation and System Information
www.dot.ca.gov/research

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DRISI

Caltrans Division of Research, Innovation and System Information

Division Chief's Message

As I compose this message, I have just completed my first year as the Chief of the California Department of Transportation's Division of Research, Innovation and System Information (DRISI), a role that continues to intrigue and challenge me as much, if not more, today as it did upon day one. DRISI is fortunate to have knowledgeable and engaged staff and research partners; vital and interesting projects; and customers eager to embrace our research outcomes to help achieve the Caltrans mission: to provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability.

Throughout this report, you will see how DRISI provides solutions and knowledge that improve California's transportation system, and thus continues to fulfill DRISI's mission. This report has four main sections.

- **Research Program Administration**—This section provides an overview of DRISI's balanced research program comprising national research programs; university transportation centers; partnered research support programs; and Caltrans functional research programs.

- **Research Task Summary**—This section is organized by functional program areas and highlights research tasks completed in FY 2015/16 and those scheduled to be completed in FY 2016/17 and FY 2017/18.

- **Research Results**—This section provides a high-level summary of selected research tasks completed in FY 2015/16, covering the research life-cycle from identification of the research need, goal, methodology, outcomes, and benefits.

- **Appendices**—The appendices list participation by Caltrans staff on committees and panels at the national level. This includes Transportation Research Board (TRB) committees and National Cooperative Highway Research Program (NCHRP) project panels, and is a strong indicator of Caltrans functional area engagement in research.

What's Ahead

DRISI will be employing the newly developed Caltrans Research Prioritization Methodology (RPM) in FY 2016/17 to align Caltrans' new research portfolio with the department's overarching strategic objectives. The RPM is a tool to objectively prioritize research proposals from varying functional areas.

DRISI will be responding to requests for matching funds from USDOT FAST ACT University Transportation Center grant awardees at California universities. California has one new National UTC grant recipient, one new Region 9 grant recipient, and one new Tier One grant recipient, as well as several California-based universities participating on out-of-state led UTCs.

As you explore this report, please take the opportunity to consider how the research highlighted herein could potentially benefit you or your functional area, or perhaps serve as the catalyst for new research concepts.

Jim Appleton, Chief
Division of Research, Innovation and System Information

Accomplishments and Innovations

Caltrans continues to find groundbreaking approaches to deliver a safe, sustainable, and integrated transportation system for all Californians. Guided by Caltrans' mission and vision, DRISI is focused on developing innovative transportation solutions and disseminating transportation-related knowledge across Caltrans.

A Better Way to Innovate: California State Transportation Innovation Council

On March 24, 2016, Caltrans and the Federal Highway Administration (FHWA) jointly chartered the California State Transportation Innovation Council (STIC) to identify and adopt innovations to improve California's transportation infrastructure, safety, and operations.

The California STIC membership reflects the diversity of the transportation industry in California. The California STIC is jointly chaired by the FHWA and Caltrans with membership from the following organizations.

- American Council of Engineering Companies
- American Public Works Association
- Association of General Contractors
- California Bicycle Coalition
- California Natural Resources Agency
- California Transit Association
- California Transportation Commission
- California Walks
- Governor's Office of Business and Economic Development
- Los Angeles County Metropolitan Transportation Authority
- National Indian Justice Center
- Pacific Merchant Shipping Association
- Professional Engineers in California Government
- Rural Counties Task Force
- Sacramento Area Council of Governments
- Silicon Valley Leadership Group
- Southern Californian Association of Governments
- University of California Center on Economic Competitiveness in Transportation
- Women's Transportation Seminar

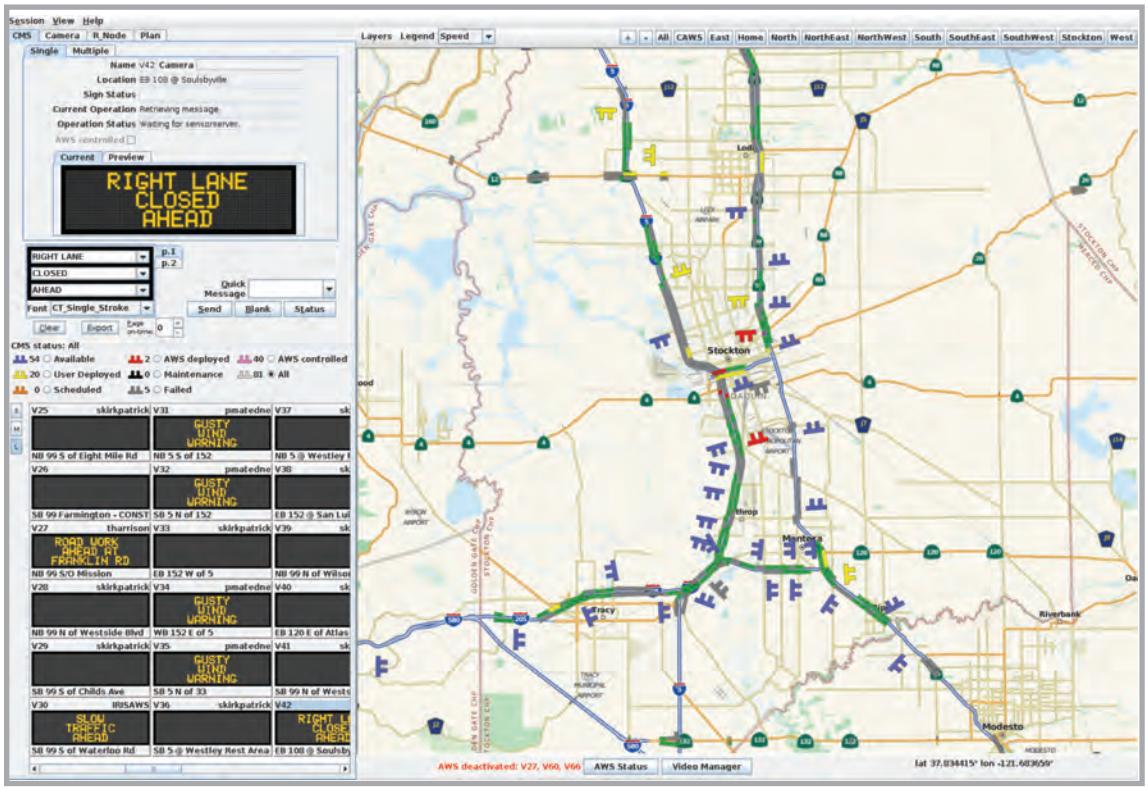
For the federal FY 2016, the California STIC nominated three projects—accelerated bridge construction, first-mile/last-mile innovation training, and roadway departure—all approved by FHWA, making full use of the available FHWA $100,000 funding and capturing an additional $35,000 allocation from DRISI.

Potential future projects include port container turnaround, automated traffic signal performance measures, community connections, integrating the National Environmental Policy Act and permitting, and the when, where, and how of pavement preservation.

IRIS: A Low-Cost, Integrated Advanced Traffic Management System for Rural Districts

Caltrans deployed the Intelligent Roadway Information System (IRIS) in four districts. IRIS offers rural areas a robust and unified traffic management program that is extendible, scalable, and reliable. Traffic management operators can centrally manage traffic devices and applications with a single integrated interface. IRIS employs an open-source methodology that reduces the life-cycle costs by approximately 72 percent, compared to the advanced traffic management system software used in urban areas. Initially created by the Minnesota Department of Transportation (MnDOT), Caltrans enhanced the application by adding automated warning, the Performance Measurement System, closed-circuit television (CCTV), changeable message signs, and integrated mapping.

In 2016, IRIS received the American Association of State Highway and Transportation Official (AASHTO) High Value Research project award, one of the highest acknowledgements a research project can achieve through the AASHTO Standing Committee on Research's program. Many other state agencies have recognized IRIS's value, and as a result, Caltrans and MnDOT are leading a Transportation Pooled Fund study to guide the future of IRIS and its open-source methodology and work with other partners to foster a better and more efficient traffic management system.



Traffic managers can monitor conditions on a map and control CCTV cameras in an integrated interface.

Research Program Administration

DRISI manages a balanced, comprehensive portfolio of projects to address the research and operational needs across Caltrans. The division seeks to take advantage of strategic collaboration opportunities by identifying public, academic, and private partnering solutions for conducting research. These partnerships leverage the dollars invested in present and future public infrastructure.

The objective of DRISI's research program is to efficiently administer research tasks from idea to product for customers in Caltrans' programs and districts. To accomplish this, DRISI allocates research funds in six categories:

- Caltrans functional research
- University transportation centers
- National research program
- State research support partnerships (research centers)
- Technology transfer and implementation
- Roadside safety research (crash testing)

The research program's two main funding sources are the federal State Planning and Research (SP&R) program and the State Highway Account (SHA). These funds support researching new knowledge areas, developing technologies that turn findings into practical applications, and transferring these technologies and innovations into practice through dissemination, demonstration, training, and adoption. In FY 2015/16, DRISI managed a $24.5 million research program to deliver research results and products that addressed transportation challenges across California.

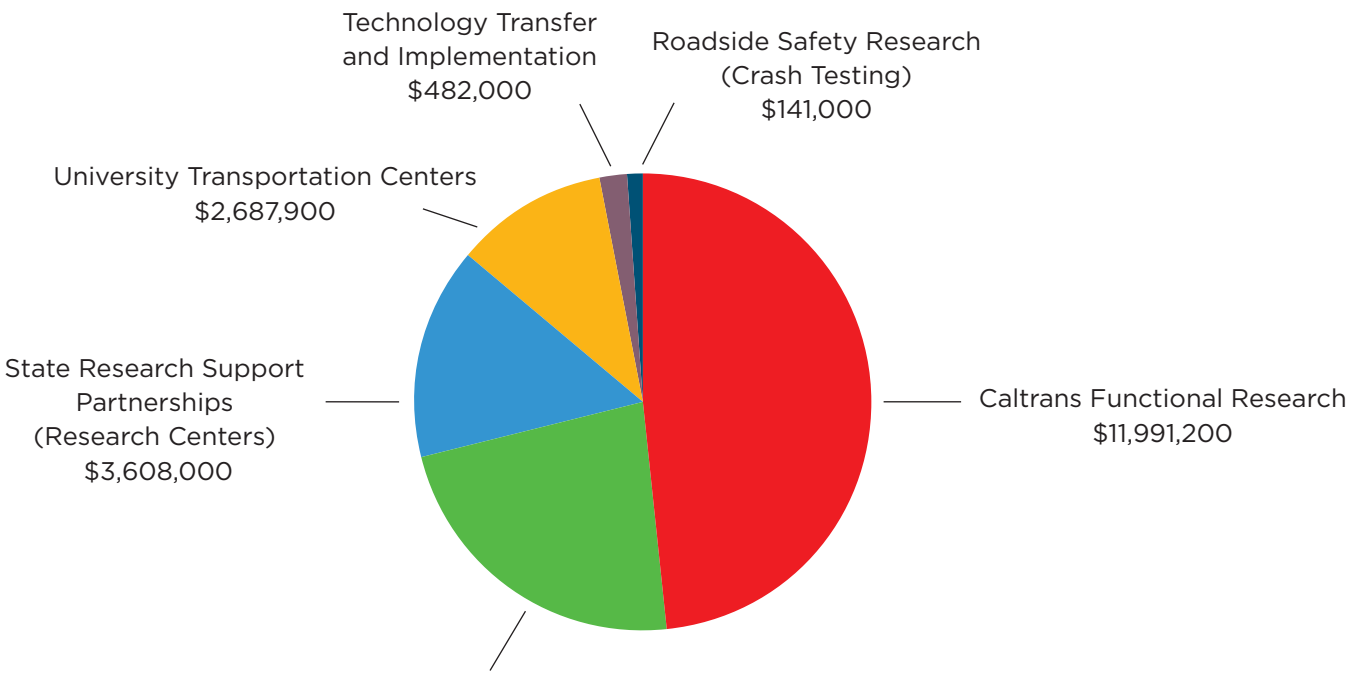
The SP&R program provided $19.6 million (80%) of DRISI's FY 2015/16 research program budget. DRISI used these monies to:

- Fund state-specific transportation research tasks identified as Caltrans functional research
- Support the national transportation research program, which includes the National Cooperative Highway Research Program (NCHRP) and the Transportation Research Board (TRB)

The SHA fund provided $4.9 million (20%) of DRISI's FY 2015/16 research program budget. DRISI used SHA monies to:

- Provide match funding for federally funded research tasks
- Fund university transportation centers
- Support technology transfer and implementation of research results and products
- Assist state research support partnerships (research centers)
- Fund roadside safety research (crash testing)

Allocation of FY 2015/16 Research Funds

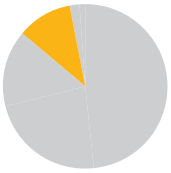


Total FY 2015/16 funding
$24,481,100

FUNDING CATEGORIES

Caltrans Functional Research | $11,991,200

The Caltrans functional research portfolio includes transportation research that addresses the areas of construction, design, environment, geotech/structures, maintenance, multimodal transport, pavement, planning, policy, programming, right-of-way, rural concerns, and transportation safety. Tasks are selected through the process described in “Research Program Development” and grouped by functional areas to align with Caltrans’ core programs. In FY 2015/16, DRISI managed 305 research tasks covering various functional areas, of which 95 reached completion. For a summary of all research tasks underway in FY 2015/16, see "Research Task Summary."



University Transportation Centers | $2,687,900

University transportation centers (UTC) are internationally recognized centers of excellence that are fully integrated within institutions of higher learning. The UTC program is administered by the U.S. Department of Transportation (U.S. DOT). The program advances transportation technology and expertise through research, education, and technology transfer; provides a critical transportation knowledge base outside of the U.S. DOT; and addresses the workforce needs for the next generation of transportation leaders.

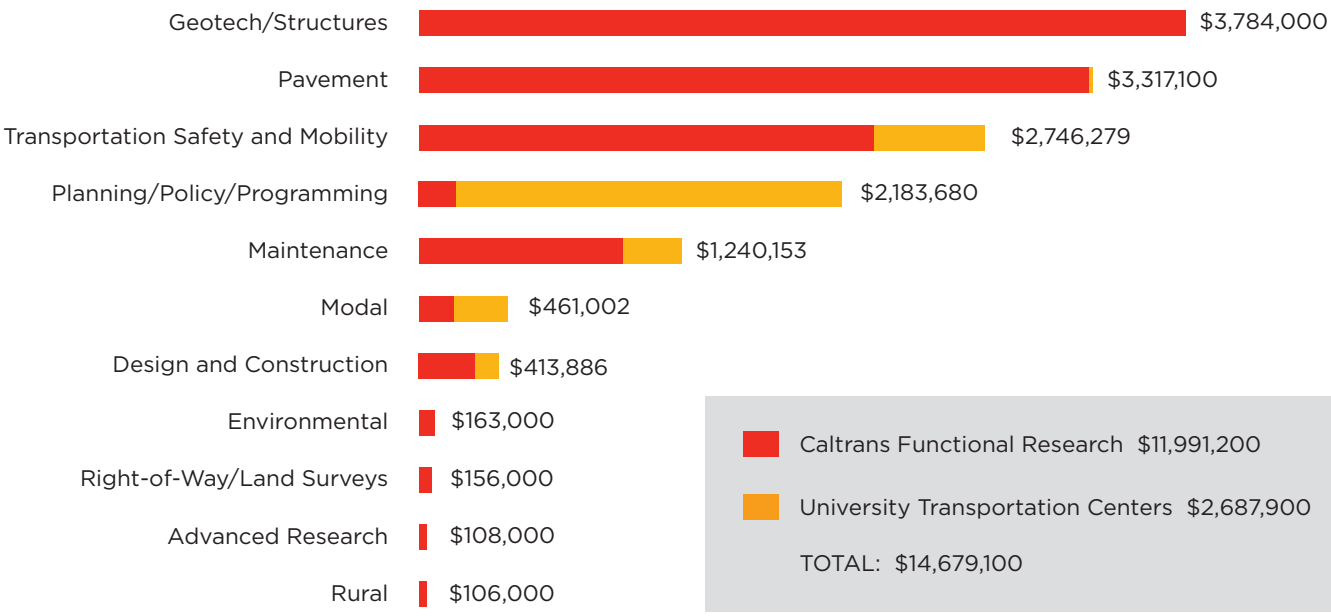
DRISI works in partnership with UTCs to identify, research, and develop solutions for California’s transportation challenges. In FY 2015/16, DRISI provided match funding for five UTCs:

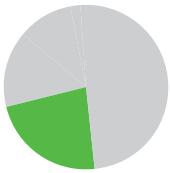
- METRANS Transportation Center
- Mineta National Transit Research Consortium
- National Center for Sustainable Transportation
- University of California Center on Economic Competitiveness in Transportation
- University of California Transportation Center

For information about the UTCs, see “University Transportation Centers.”

The following graph shows the breakdown of research by functional area for the combined research totals of the Caltrans Functional Research program and the UTCs.

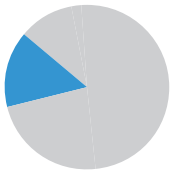
Distribution of Caltrans Functional Research and UTC Funds by Research Area





National Research Program | $5,571,000

Caltrans partners with national transportation organizations, including the TRB and the National Cooperative Highway Research Program (NCHRP). Caltrans benefits from national research efforts through leveraging research conducted at the national level and by serving on committees and panels that identify critical transportation issues, recommend project selection, and guide implementation. More information about these national programs is in "National Research Programs." In FY 2015/16, Caltrans staff actively participated on 106 highway, 11 freight, 3 airport, and 1 transit cooperative research project panels (see Appendices 2–5).

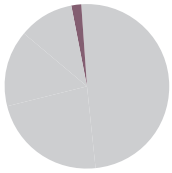


State Research Support Partnerships (Research Centers) | $3,608,000

DRISI partners with university-based research centers to deliver research results and products. Each research center offers specialized technical expertise and state-of-the-art facilities, equipment, and materials.

- Advanced Highway Maintenance and Construction Technology Research Center (AHMCT)
- Pacific Earthquake Engineering Research Center Lifelines Program (PEER)
- Partners for Advanced Transportation Technology (PATH)
- Sustainable Transportation Energy Pathways (STEPS)
- University of California Pavement Research Center (UCPRC)

More information about the following research centers is in "State Research Support Partnerships."



Technology Transfer and Implementation | $482,000

Promoting the implementation of research results into Caltrans routine practice requires multichannel, sustained technology transfer. DRISI uses various tools and methods to encourage the adoption of research results and products. These efforts include communication and engagement with DRISI customers and stakeholders.

Research products are the mechanism by which Caltrans is encouraged to make changes to business practices, with the goal of improving organizational effectiveness and efficiency. The research products are categorized by one or more of the following:

- New or improved technical standard, plan, or specification
- New or improved manual, handbook, guidelines, or training
- New or improved policy, rule, or regulation
- New or improved business practice, procedure, or process
- New or improved tool or equipment
- New or improved decision support tool, simulation, model, or algorithm (software)
- Processed data/database
- Evaluation of new commercial products to determine if they meet Caltrans' needs

DRISI uses various methods to communicate research results and products. Informational and outreach activities include:

- Conferences and forums
- Demonstrations and training
- Meetings, presentations, and webinars
- Research events and workshops

Print and web-based publications and materials include:

- **Annual Research Program Highlights reports** showcase DRISI's activities and completed research.
  www.dot.ca.gov/research/researchreports/index.htm
- **Final reports** document the executed methodology, detailed findings, and technical analysis of the research tasks.
  www.dot.ca.gov/research/researchreports/dri_reports.htm
- **Preliminary Investigation reports** provide a comprehensive overview of historical and existing national and international research and best practices for defined research needs.
  www.dot.ca.gov/research/researchreports/preliminary_investigations/index.htm
- **Research Notes** give an overview of research in progress to a general audience. Released at the beginning of a research task, the notes describe the need, methodology, goal, benefits, milestones, and next steps.
  www.dot.ca.gov/research/researchreports/current_research/index.htm
- **Research Results** communicate to a general audience what was accomplished with the research. They summarize the need, goal, methodology, outcome, and benefits.
  www.dot.ca.gov/research/researchreports/technical_summaries.htm

Roadside Safety Research (Crash Testing) | $141,000

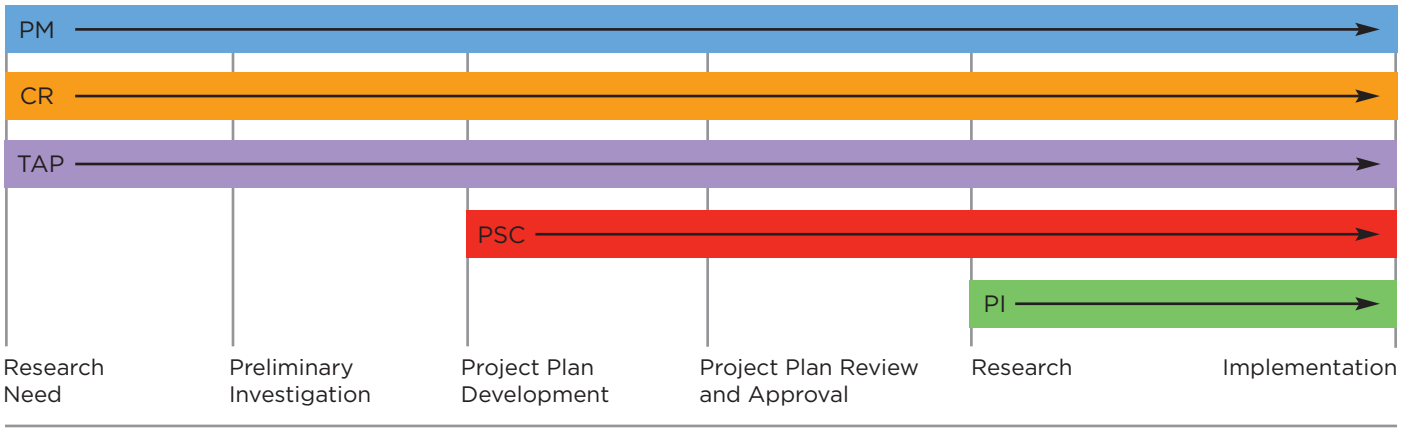
DRISI's Roadside Safety Research group evaluates the crash worthiness of safety technology, such as barriers, guardrails, crash cushions, bridge rails, sign supports, and other hardware. It conducts full-scale crash tests on roadside safety hardware designs developed by Caltrans to ensure that these designs comply with applicable crash performance criteria. The group also evaluates the crash worthiness of proprietary hardware developed by others to ensure that it is acceptable for use on state highways. The group provides support to Caltrans Legal Division in tort liability cases by conducting crash tests and delivering technical assessments and expert witness testimony.

RESEARCH PROGRAM DEVELOPMENT

DRISI engages the Caltrans Executive Board and three levels of committees in identifying research needs, selecting research projects, and deploying and implementing research products. The Executive Board provides strategic direction and identifies department-level research priorities. The Research and Deployment Advisory Committee (RDAC) recommends research and funding and actively sponsors the deployment and implementation of the resulting research products. The RDAC can include district directors, deputy district directors, and headquarter division chiefs, who might also lead one of the program steering committees (PSC). The PSCs adopt an agenda for a multiyear integrated research program. Each PSC has at least one technical advisory panel (TAP), which includes experts from the various divisions and districts. The TAPs act in an advisory role to the PSC.

In coordination with PSC leads, DRISI project managers propose new research projects. The PSCs and DRISI management review the proposals in March. PSC leads prioritize their respective proposals in March, and the RDAC recommends the portfolio in April.

Research Process and Roles



Project Manager (PM)
DRISI staff member with full authority and responsibility, delegated by the appropriate office chief, to manage projects and produce the intended results on schedule and within budget. The PM keeps the project sponsors, customers, stakeholders, and end users satisfied by managing all aspects of the approved project, from the initial problem statement to a deployable product.

Customer Representative (CR)
A representative from one of Caltrans' program areas who participates as a liaison between DRISI and the PSC and takes ownership of the final research product.

Technical Advisory Panel (TAP)
Each TAP has a vital role in evaluating research needs, providing recommendations for continuing and new projects, developing and ranking project plans and requests for preliminary investigations, and identifying opportunities for deployment and implementation of research products.

Program Steering Committee (PSC)
Each PSC has an essential role in generating new research projects, developing program-level research priorities, and supporting the deployment and implementation of research products.

Principal Investigator (PI)
Contractor or researcher responsible for research conduct and the completion of the contract obligations.

National Research Programs

Caltrans partners with national transportation organizations and benefits from leveraging research conducted at the national level.

Transportation Research Board

The Transportation Research Board (TRB), the major national multimodal transportation research organization, brings practitioners and researchers together to solve critical transportation problems. With more than 200 standing committees, almost every transportation mode and topic is represented. Each committee proposes research, shares research findings, sponsors special activities, and provides a forum for transportation professionals to discuss current and future transportation issues.

The TRB's major sources of revenue are state departments of transportation, federal agencies, other transportation organizations, and TRB self-generated revenue. With a contribution of $495,641 in 2016, Caltrans was able to leverage $32 in research-related activity for every $1 invested.

This beneficial investment in TRB enables Caltrans to:

- Have a voice in setting national research priorities and agendas
- Access user-oriented research
- Avoid duplication of research efforts
- Support the uniform, practical, and common-sense application of transportation research results
- Develop a more informed and forward-thinking workforce
- Improve customers' experiences by accelerating the development and implementation of solutions to problems that affect transportation planning, design, construction, operation, and maintenance
- Retain employees by offering stimulating and professionally rewarding opportunities to participate in efforts that help improve the nation as a whole

National Cooperative Research Programs

The National Cooperative Research Programs address research on safety, planning, design, construction, operations, and maintenance at the national level. This research includes developing and evaluating new technologies and techniques. The programs also foster sharing best practices among states.

Caltrans leaders work with the following national research programs:

- National Cooperative Highway Research Program (NCHRP)
- Transit Cooperative Research Program (TCRP)
- National Cooperative Freight Research Program (NCFRP)
- Airport Cooperative Research Program (ACRP)

In 2016, the National Cooperative Highway Research Program selected 35 new projects for funding, of which 12 were important to Caltrans and 9 were of significant interest. Caltrans staff is currently serving on 20 of the new project panels. As project panel members and a member of the Standing Committee on Research and Research Advisory Council, Caltrans is able to influence national projects to directly benefit California.

Transportation Pooled Fund Program

When significant or widespread interest is shown in solving transportation-related problems, several federal, state, regional, and local transportation agencies, academic institutions, foundations or private firms might jointly fund research, planning, and technology transfer activities. The Transportation Pooled Fund (TPF) program combines resources to support transportation research studies.

State Research Support Partnerships

DRISI partners with university-based research centers to deliver research results and products. Each research center offers specialized technical expertise and state-of-the-art facilities, equipment, and materials.

Advanced Highway Maintenance and Construction Technology Research Center

The AHMCT Research Center is located at the University of California, Davis. Its mission is to improve the safety, mobility, and reliability of California's highways, achieve lean operations, and minimize environmental impacts while considering life-cycle assessments, sustainability, and cost-benefits. AHMCT uses advanced robotics, automation, sensing, networking, and information technologies in completing applied research that supports Caltrans in the areas of highway and civil infrastructure construction, maintenance, and operations.

Because Caltrans' first of five goals is safety and health, much of the research performed at AHMCT focuses on or has a strong safety element. Recent research efforts have sought to automate traditionally labor-intensive tasks to get maintenance and construction workers away from live traffic lanes. To accomplish this, a mix of evaluating available commercial systems and original research is undertaken. AHMCT determines whether a commercial system provides value to Caltrans in terms of safety, mission support, cost savings, and operational efficiency. When suitable commercial systems are not available, AHMCT conducts applied research to develop systems and equipment to meet Caltrans' needs and specifications. AHMCT also supports Caltrans by completing preliminary investigation reports that are generated prior to undertaking new research and hosting peer exchange workshops that bring knowledge to Caltrans staff from subject matter experts at federal, state, and local entities.

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Pacific Earthquake Engineering Research Center Lifelines Program

The PEER-Lifelines Program, located at UC Berkeley, is a partnership between lifeline providers that share a common interest in improving the response to seismic hazards. The multi-institutional research and education center focuses on developing performance-based earthquake engineering methods and design tools to better characterize potential threats due to severe ground shaking, fault rupture, soil liquefaction, and tsunami inundation.

California, located at the boundary of the Pacific and North America tectonic plates, has the greatest seismic risk exposure of any state in the country. About 13,000 Caltrans–owned bridges and a roughly equal number of local agency–owned bridges face seismic risk. Caltrans' priority is to ensure that the roadways and bridges are safe and can support emergency response and regional recovery efforts. To achieve these goals economically, accurate characterization of potential threats is necessary. Some locations are more vulnerable than others because of their proximity to active faults or poor soil conditions. PEER-Lifelines develops statistical models that characterize various earthquake-related hazards to improve the understanding of where these high-risk locations are and how large the seismic demands might be. These models are then incorporated into Caltrans design procedures to advance cost-effective mitigation strategies.

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peer.berkeley.edu

Partners for Advanced Transportation Technology

PATH is a statewide research program in Intelligent Transportation Systems (ITS) focusing on improving safety, system performance, accessibility, and sustainability with advanced ideas and technologies, emphasizing field operational testing leading to deployment. The added benefits of the research include reduced energy consumption, better land-use management, improved transportation equity for all users, and strengthening California's economic vitality.

PATH conducts leading-edge research, evaluating the benefits and feasibility of relevant ITS technologies and conducting controlled experiments and field operational tests. PATH develops public, private, and academic partnerships to facilitate the creation, advancement, and deployment of these technologies in California. It also educates students, transportation practitioners and Caltrans personnel on conducting these research activities and field tests, focusing on operational benefits that result from research in ITS.

PATH also assists Caltrans and California in understanding and preparing for the adoption of emerging transportation technologies that hold promise to significantly improve traveler safety, reduce traffic congestion, encourage the use of alternative transportation modes, and facilitate the movement of goods and services while simultaneously reducing greenhouse emissions and the detrimental impact of transportation on land use and sprawl.

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www.path.berkeley.edu

Sustainable Transportation Energy Pathways

Focused on the future roles of alternative fuels and vehicles, the current UC Davis STEPS program is a four-year (2015–18) multidisciplinary research consortium. Sponsored through a private-public collaboration, STEPS promotes the transition to a sustainable transportation energy future by generating the theory, tools, and methods to compare promising alternative energy sources. The program addresses the uncertainty that governments and the private sector face in developing new fuel-vehicle pathways, highlighting the necessity of a comprehensive approach in reducing oil use and greenhouse gas emissions. STEPS disseminates knowledge and tools to industry, government, the environmental NGO community, and the general public. STEPS researchers host webinars and annual workshops for consortium members to collaborate on sustainable vehicle and energy solutions and inform industry planning and government policy with timely and sophisticated science-based analysis.

California put forth the Hydrogen Highway Initiative in 2004, resulting in a partnership between Caltrans and the University of California, Davis to research the use of hydrogen for transportation applications. Since then, other alternative fuel types (electricity, natural gas, and biofuels) have shown both promise and practicality. The STEPS comparative analysis provides Caltrans a full research portfolio of these alternative fuel types and the potential impacts and challenges to public-sector entities and policy makers. Additionally, the findings produced by STEPS researchers have helped Caltrans staff obtain a greater understanding of how alternative fuels are changing the transportation landscape for both Caltrans and the society at large.

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University of California Pavement Research Center

UCPRC is a major component in the statewide pavement program, focusing on improving the durability and management of pavements. UCPRC is multidisciplinary, addressing the areas of pavements, structures, materials, mechanical, environmental, transportation, geotechnical, and chemistry, with research programs at both UC Davis and UC Berkeley. Its goals include implementing mechanistic-empirical design, incorporating recycling and sustainability, developing quieter pavements, enhancing construction practices and project delivery, and implementing smoothness.

California's economy depends on the ability to move goods rapidly and without damage. California's traveling public expects a safe and efficient transportation network. As resources become limited, Caltrans must find ways to maintain and improve its extensive pavement infrastructure. UCPRC provides expertise in areas that Caltrans requires to maintain this critical transportation infrastructure.

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University Transportation Centers

In FY 2015/16, Caltrans provided state match funding for five California UTCs. Two of them, the Mineta National Transit Research Consortium (MNTRC) and the University of California Transportation Center (UCTC), continued to receive funding under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU).

The Moving Ahead for Progress in the 21st Century Act (MAP-21) provided federal funding for the other three UTCs: the METRANS Transportation Center; the National Center for Sustainable Transportation (NCST); and the University of California Center on Economic Competitiveness in Transportation (UCCONNECT). In the federal FY 2015, the U.S. DOT awarded the three MAP-21 UTCs partial-year grants, augmenting and extending their existing grants.

The UTCs are fully integrated within institutions of higher learning and provide a vital source of leaders prepared to meet the nation's need for safe, efficient, and environmentally sound movement of people and goods. The centers work in partnership with DRISI to support the research needs of Caltrans and the state of California, primarily in the areas of mass transportation, rail, traffic operations, and transportation planning.

SAFETEA-LU University Transportation Centers

MNTRC, led by the Mineta Transportation Institute at San José State University, provides expertise on alternative fuels, safety and security, public policy, finance, workforce development, livable communities, environmental sustainability, economic competitiveness, new modes, and other critical factors essential to sustainable mobility. MNTRC primarily supports the research needs of Caltrans' divisions of Rail and Mass Transportation and Transportation Planning. Consortium members include:

- Bowling Green State University
- Grand Valley State University
- Howard University
- Penn State University
- Rutgers, The State University of New Jersey
- University of Detroit Mercy
- University of Nevada, Las Vegas
- University of Toledo

UCTC, led by the University of California, Berkeley, focuses on environmental sustainability, economic competitiveness, and livability and the connections between them. UCTC primarily supports the research needs of Caltrans' divisions of Rail and Mass Transportation and Transportation Planning. Consortium members include:

- University of California, Davis
- University of California, Irvine
- University of California, Los Angeles
- University of California, Riverside
- University of California, Santa Barbara

Affiliate members include:

- California Polytechnic State University, San Luis Obispo
- California State Polytechnic University, Pomona
- California State University, Sacramento
- California State University, San Bernardino

MAP-21 University Transportation Centers

METRANS, led by the University of Southern California, is a two-member consortium that includes California State University, Long Beach. METRANS conducts an integrated, multidisciplinary program of research aimed at increasing the economic competitiveness of large metropolitan areas through improved transportation system performance, addressing passenger and freight across all surface transportation modes. METRANS primarily supports the research needs of Caltrans' divisions of Rail and Mass Transportation, Transportation Planning, and Traffic Operations.

NCST, led by the University of California, Davis, addresses the U.S. DOT's strategic goal to advance environmentally sustainable policies and investments by asserting national leadership in reducing carbon emissions from transportation systems while supporting climate adaptation activities and continued mitigation of air pollution and other environmental impacts. NCST primarily supports the research needs of Caltrans' Division of Transportation Planning. Consortium members include:

- California State University, Long Beach
- Georgia Institute of Technology
- University of California, Riverside
- University of Southern California
- University of Vermont

UCCONNECT, led by the University of California, Berkeley, promotes economic competitiveness, pursuing projects to reduce congestion, improve highway operations, and enhance freight movement. UCCONNECT primarily supports the activities of Caltrans' divisions of Rail and Mass Transportation, Transportation Planning, and Traffic Operations. Consortium members include:

- University of California, Irvine
- University of California, Los Angeles
- University of California, Riverside
- University of California, Santa Barbara

California State Polytechnic University, Pomona is an affiliate member.

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Research Task Summary

The Research Task Summary lists selected research tasks completed in FY 2015/16 and scheduled to be completed in FY 2016/17 or 2017/18 that highlight the breadth of the research program. Tasks are arranged by functional program areas, with transportation pooled funds (TPF) listed separately, in ascending order by task end date. For tasks appearing in bold, a Research Results summary document is included in this report on the page number indicated.

Research tasks completed in FY 2015/16

Research tasks scheduled to be completed in FY 2016/17 or 2017/18

Advanced Research

Task ID	Task Title	Task Manager	End Date	Page #
2234	Dedicated Short Range Communications (DSRC) for Work Zones and Major Incident Management	Gwynne, Gloria	9/15/15	-
2819	**UTC - Vehicle-to-Vehicle Communications in Mixed Passenger-Freight Convoys (METRANS)**	**Siddiqui, Asfand**	**12/31/15**	34
2536	Clean, Green and Smart Corridor Development: MCOM Advance Adoption of Alternative Fuel Commercial Vehicles	Hanson, Matt	8/31/16	-
2962	A Cooperative V2V Alert System to Mitigate Vehicular Traffic Shock Waves	Siddiqui, Asfand	4/30/17	-
2623	Partial Automation for Truck Platooning	Hanson, Matt	12/29/17	-
2910	Early Opportunities to Apply Automation in California Managed Lanes	Siddiqui, Asfand	12/31/17	-

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2405	**Evaluation of Photo Speed Enforcement (PSE) in California Work Zones**	**Nagra, Sukhdeep**	**9/30/15**	36
2524	Validating the Effects of Collaborative Partnering on Major Capital Projects	Chung, Haniel	8/1/16	-
2982	Sustainable Mitigation of Stormwater Runoff through Fully Permeable Pavement	Provost, Leanne	4/30/17	-
3097	Developing an Interactive Machine-Learning-based Approach for Sidewalk Digitalization	Tyner, Patrick	9/30/17	-
2966	Support for the Highway Performance Monitoring System (HPMS)	Holland, Joe	11/30/17	-

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2812	UTC - Urban Spatial Structure, Employment Sub-Centers and Passenger and Freight Travel (METRANS)	Hanson, Matt	8/14/15	-
2831	UTC - Spatial Dynamics of the Logistics Industry and Implications for Freight Flows (NCST)	Hanson, Matt	2/15/16	-

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0918	**Development of Aesthetic, Low-Maintenance Guardrail System Alternatives**	**Caldwell, Christopher**	**11/10/15**	38
2530	Environmental Effects of Cured-in-Place Pipe (CIPP) Repairs	Benouar, Azzeddine	12/31/16	-
2997	Richmond-San Rafael Bridge Access Improvements Evaluation	Mizuno, Bradley	9/30/17	-

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2259	Support of the Transportation Curriculum Coordination Council (TCCC), TPF-5(209)	Buendia, Robert	12/1/17	-

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2824	**UTC - Do California Highways Act as Barriers to Gene Flow for Ground-Dwelling Mammals? (NCST)**	**Hunt, Harold**	**4/15/16**	40
3074	The Environmental Effects of New Mobility Services	Azevedo, Christine	3/31/17	-
2978	Using Non-Invasive Genetics to Compare How a California Freeway Affects Gene Flow in a Disturbance-averse Versus a Disturbance-tolerant Species	Turner, Loren	6/30/17	-
2724	Development of a Tidewater Goby Survey Method Using Environmental DNA	Turner, Loren	12/31/17	-

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1578	FHWA Traffic Noise Model: Version 3.0 Software and Training, TPF-5(158)	Turner, Loren	6/30/17	-
1579	Tire/Pavement Noise Research Consortium, TPF-5(135)	Turner, Loren	9/1/17	-
2538	Near Road Air Quality Research, TPF-5(284)	Turner, Loren	12/31/17	-
2776	Underwater Noise Attenuation Experimental Methods, TPF-5(323)	Buendia, Robert	12/31/17	-

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2516	**Light Fleet In-vehicle Data Acquisition System (FIDAS) Evaluation**	**Perez, Jose**	**9/30/15**	42
2738	Evaluation of Equipment Production and Procurement Practices	Benouar, Azzeddine	3/31/17	-
2737	Fleet Replacement Model Evaluation and Refinement	Benouar, Azzeddine	6/30/17	-

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2578	Calibration of LRFD Geotechnical Axial (Tension and Compression) Resistance Factor for Driven Piles and Drilled Shafts	Shantz, Tom	8/31/16	-
2933	Simulation of Liquefaction-induced Damage of the Port of Long Beach Using the UBC3D-PLM Model	Benouar, Azzeddine	9/1/16	-
2934	Development of an Economic Framework to Evaluate Resilience in Recovering from Major Port Disruptions	Provost, Leanne	9/1/16	-
2747	Bridge Strong Motion Instrumentation System Data Recovery	Hipley, Pat	9/30/16	-
2342	Creep and Shrinkage Effects On Columns	Sikorsky, Charles	12/31/16	-
2346	Controlling Temperature and Shrinkage Cracks in Bridge Decks and Slabs	Lee, Peter	1/1/17	-
2111	Geophysical Methods for Determining the Geotechnical Engineering Properties of Earth Materials	Owen, Bill	3/31/17	-
2605	Reusable Instrumented Test Pile Phase 2	Shantz, Tom	3/31/17	-
2532	Assessment of Soil Arching Factor for Retaining Wall Pile Foundations (Phase I)	Sikorsky, Charles	5/31/17	-
1805	Corridor-Scale Landslide Hazard Mapping: Conversion of CGS Hazard Maps	Roblee, Cliff	6/30/17	-

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2557	Compliance Crash Testing of a MASH 2009 Test Level 4 Side Mounted Bridge Rail	Her, Vue	6/30/17	-
2572	Anchorage Zone Reinforcement of Post-Tensioned Box Girder Bridges	Lee, Peter	11/1/17	-
3023	LFD and LRFD Capacity of Steel Pin and Hanger Assembly	Sikorsky, Charles	1/31/18	-
2781	Post Tensioned Box-Girder Deck Replacement Method	Lee, Peter	3/1/18	-

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2444	Peer Exchange and Review of Deep Foundation Testing Methodologies at Caltrans, TPF-5(263)	Hunt, Harold	6/30/16	-
1097	Structural Health Monitoring System, TPF-5(219)	Sikorsky, Charles	9/30/16	-
1648	Application of Three-Dimensional Laser Scanning for the Identification, Evaluation, and Management of Unstable Highway Slopes, TPF-5(166)	Lofton, Arvern	12/11/16	-
2489	Passive Force-Displacement Relationships for Skewed Abutments, TPF-5(264)	Sikorsky, Charles	12/31/17	-
2298	Evaluation of Seismic Performance of Earth Retaining Structures, TPF-5(276)	Shantz, Tom	6/30/18	-

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2167	Implementation and Evaluation of the Snowplow Driver Assistance System	Baumeister, Larry	8/30/15	-
2944	Traction Control Devices Durability Study	Mizuno, Bradley	9/18/15	-
2299	Mobile Real-Time Information System for Snow Fighter Supervisors - System Design & Test	Baumeister, Larry	9/30/15	-
2335	**Improved Deicing Methods for Snow and Ice removal: Epoke Evaluation**	**Baumeister, Larry**	**9/30/15**	**46**
2336	Evaluation of the TowPlow Trailer System	Baumeister, Larry	9/30/15	-
2337	**Evaluation of GPS-based Mountain Pass Opening for Tioga Pass**	**Baumeister, Larry**	**9/30/15**	**48**
3043	Visibility Standards for Field Worker Apparel and Personal Protective Equipment	Nagra, Sukhdeep	7/31/16	-
2953	Using Mechanical Ice Breakers to Improve Snow and Ice Removal Operations	Unck, Justin	8/1/16	-
2887	Solar Lighting Evaluation for Highway Applications	Mizuno, Bradley	12/30/16	-
2990	Field Testing of the Snowplow Driver Assistance System	Baumeister, Larry	5/23/17	-
2981	Introducing Resilience into the State Transportation Network	Williams, Scott	5/31/17	-
2521	Dynamic Transit Trip Planner (DTTP) Interactive Transit Station Information System (ITSIS)	Mizuno, Bradley	6/30/17	-
2734	Avalanche Mapping Study	Baumeister, Larry	6/30/17	-
3065	Henderson Products Spreader Evaluation	Baumeister, Larry	6/30/17	-
2732	Evaluation of Devices for Improving Traction Control in Winter Conditions	Mizuno, Bradley	9/30/17	-
2748	Determination of In-situ Precast Concrete Girder Compressive Strength	Baumeister, Larry	12/31/17	-
3085	Continued Evaluation of the TowPlow Trailer System	Baumeister, Larry	12/31/17	-

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2473	Clear Roads Winter Highway Operations, TPF-5(218)	Baumeister, Larry	9/30/16	-
1729	In-situ Scour Testing Device, TPF-5(210)	Flora, Kevin	12/30/16	-

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2627	UTC - Integrating Highway and Transit Data into Benefit-Cost Analysis (MNTRC)	Ziaullah, Fouad	9/30/15	-
2631	UTC - Promoting Intermodal Connectivity at California's High Speed Rail Stations (MNTRC)	Tyner, Patrick	11/30/15	-
1768	**Integration of AWOS with RWIS - Phase 2 - Prepare System for Deployment**	**Clark, Melissa**	**12/31/15**	**50**
2629	UTC - Comparing Modes of On-Board Transit Passenger Surveys: Assessing Trade-offs between Data Quality and Cost (MNTRC)	Ziaullah, Fouad	12/31/15	-
2630	UTC - Performance Measurement and Transit Data (MNTRC)	Saetern, Lai	12/31/15	-
2634	UTC - Bicycling and Access to Transit by Low-Income Immigrants (MNTRC)	Chursenoff, David	12/31/15	-
2820	**UTC - Smart Truck Driver Assistant: A Cost Effective Solution for Real Time Management of Container Delivery to Trucks (METRANS)**	**Hanson, Matt**	**12/31/15**	**52**
2642	UTC - An Activity-based Toolbox for Planning Applications with Special Relevance to Transit (UCTC)	Chursenoff, David	1/30/16	-
2499	Pricing Your Way to Operational Efficiency: One-Way Electric Vehicle Carsharing in San Diego	Chursenoff, David	3/31/16	-
2873	UTC - Coordinating Transit Transfers in Real Time (UCCONNECT)	Saetern, Lai	4/1/16	-
2875	UTC - Analyzing Spread of Influence in Social Networks for Transportation Applications (UCCONNECT)	Araya, Juan	4/1/16	-
2633	UTC - The Purpose, Function, and Performance of Streetcar Transit in the Modern U.S. City: A Multiple Case Study Investigation (MNTRC)	Rudulph, Kimberly	4/13/16	-
2637	UTC - International Lessons for Promoting Transit Connections to High-Speed Rail Systems (MNTRC)	Tyner, Patrick	4/30/16	-
2806	**UTC - Promoting Peer-to-Peer Ridesharing Services as Transit System Feeders (UCCONNECT)**	**Chursenoff, David**	**5/1/16**	**54**
2866	Bringing a Community Health Lens to Highway-to-Main Street Conversions	Gwynne, Gloria	5/31/16	-
2802	**UTC - Heightening Walking Above Its Pedestrian Status: Walking and Travel Behavior in California (UCCONNECT)**	**Gwynne, Gloria**	**6/30/16**	**56**
2860	Rail and the California Economy	Azevedo, Christine	12/30/16	-
2969	A Comparative Analysis of High Speed Rail Station Development into Destination and/or Multi-use Facilities	Tyner, Patrick	2/28/17	-
2964	Designing a Transit-Feeder System Using Bikesharing and Peer-to-Peer Ridesharing	Lao, Kayo	4/30/17	-
2664	Bus Rapid Transit (BRT) Toolbox: Assessing Person Throughput to Measure Transportation Impacts for BRT Projects	Loebs, Nathan	6/14/17	-
2663	Development and Demonstration for Integrated Dynamic Transit Operations System (IDTO)	Loebs, Nathan	5/31/18	-

Pavement

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2823	UTC - White Paper on the Application of Permeable Pavement with Emphasis on Successful Design, Water Quality Benefits, and Identification of Knowledge and Data Gaps for Sustainable Transportation (NCST)	Wang, Yue	9/30/15	-
2827	**UTC - Evaluation of the Combined Effect of Recycled Asphalt Pavement (RAP), Recycled Asphalt Shingles (RAS), and Different Virgin Binder Sources on Performance of the Blended Binder for Mixes with Higher Percentages of RAP and RAS (NCST)**	**Sadraie, Hamid**	**9/30/15**	**58**
2789	Support for the Long Term Pavement Performance (LTPP) Program	Yang, John	6/30/17	-
2878	Evaluate Early Age and Premature Cracking for PaveM and LCCA (whitetopping)	Wang, Yue	7/31/17	-
2667	Standard Materials Library and Guidance	Holland, Joe	9/30/17	-

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2668	Improved ME Design Algorithms and Reliability Approach	Yang, John	9/30/17	-
2671	Performance-Related Specifications for Rubberized Asphalt Binder	Yang, John	9/30/17	-
2672	Support for Superpave Implementation	Yang, John	9/30/17	-
2673	Simplified Performance Based Specifications for AC Long Life Projects	Yang, John	9/30/17	-
2674	Performance Models for Seal Coats in PaveM	Holland, Joe	9/30/17	-
2675	Update project level asphalt surface design	Holland, Joe	9/30/17	-
2693	Guidelines for Preservation Treatments for Bicycle Routes	Holland, Joe	9/30/17	-
2718	Environmental Life Cycle Assessment Updates and Applications	Hunt, Harold	9/30/17	-
2723	Effects of Pavement Roughness on Freight Movement	Holland, Joe	9/30/17	-
2676	Binder Replacement in High RAP/RAS Asphalt Mixes (Phase 1: Literature Review and Laboratory Testing)	Yang, John	11/30/17	-
2686	Evaluate Traffic Speed Deflection Measurement	Holland, Joe	11/30/17	-
2687	New Life Cycle Cost Optimization Models for PaveM	Holland, Joe	11/30/17	-
2688	Evaluate APCS Data Collection and PaveM Engineering Configuration	Holland, Joe	11/30/17	-
2689	Update PaveM Engineering Configuration	Holland, Joe	11/30/17	-
2690	Update Guidance and Calculations for Life Cycle Cost Analysis	Holland, Joe	11/30/17	-
2691	Validation of Greenhouse Gas Emissions from Pavement Deflection	Holland, Joe	11/30/17	-
2702	Improved Screening Tests for ASR	Wang, Yue	11/30/17	-
2703	Improved Smoothness and Distress Models and Benefits Equations for PaveM	Wang, Yue	11/30/17	-
2704	Evaluate Composite Pavement Performance and Decision Trees	Holland, Joe	11/30/17	-
2705	Algorithms for Grouping Segments into Projects in PaveM	Wang, Yue	11/30/17	-
2706	Document PaveM Traffic Updating Processes	Wang, Yue	11/30/17	-
2707	Improved Guidance and Specifications for Full-Depth Reclamation	Yang, John	11/30/17	-
2708	Microcracking for Cement Stabilized Layers: Phase 1 Lab Testing & Modeling	Holland, Joe	11/30/17	-
2709	Microcracking for Cement Stabilized Layers: Phase 2 HVS & Field Testing	Holland, Joe	11/30/17	-
2710	Quieter Pavement Long-term Monitoring	Wang, Yue	11/30/17	-
2713	Evaluate Early Age and Premature Cracking for PaveM and LCCA	Wang, Yue	11/30/17	-
2719	Updated Greenhouse Gas Emission Calculations in PaveM	Hunt, Harold	11/30/17	-
2722	Evaluate Linear Reference System	Nokes, Bill	11/30/17	-
2779	Improvement of Caltrans Pavement Management System (PaveM)	Holland, Joe	11/30/17	-
3024	Increasing Crumb Rubber Usage by Using Small Amounts of Crumb Rubber Modifier in Hot Mix Asphalt	Holland, Joe	11/30/17	-

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2020	**Improving the Foundation Layers for Concrete Pavements, TPF-5(183)**	**Wang, Yue**	**6/30/16**	**60**
2606	Demonstration of Network Level Pavement Structural Evaluation with Traffic Speed Deflectometer	Holland, Joe	7/19/16	-
2611	Development of an SPS-2 Pavement Preservation Experiment, TPF-5(291)	Holland, Joe	8/7/16	-
0570	Improving the Quality of Pavement Profiler Measurement, TPF-5(063)	Rodriguez, Alfredo	12/30/16	-
2258	Technology Transfer Intelligent Compaction Consortium (TTICC), TPF-5(233)	Chung, Haniel	7/3/17	-
2859	Enhancement to the Intelligent Construction Data Management System and Implementation, TPF-5(334)	Wang, Yue	12/31/17	-

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2636	**UTC - Synergistic Integration of Transportation Demand Management Strategies (Land Use, Transit, and Auto Pricing) with New Technologies and Services (Battery Electric Vehicles and Dynamic Ridesharing) to Enhance Reductions in VMT and GHG (MNTRC)**	**Tyner, Patrick**	**7/31/15**	**62**
2893	UTC - Interregional Transportation Strategic Plan (ITSP) (MNTRC)	Tyner, Patrick	7/31/15	-
2888	UTC - Park and Ride Linkage to Public Transit Service Productivity (MNTRC) of Transit Oriented Development Using a Spatial Economic Land Use and Activity-Based Microsimulation Models (NCST)	Chursenoff, David	8/30/15	-
2821	UTC - Exploring Unintended Environmental and Social-Equity Consequences	Law, Frank	8/31/15	-
2829	**UTC - What Affects Millennials' Mobility? Investigating the Environmental Concerns, Lifestyles, Mobility-Related Attitudes and Adoption of Technology of Young Adults in California (NCST)**	**Chursenoff, David**	**9/30/15**	**64**
2635	UTC - The Impact of Public Bikesharing on Bicycle Safety in North America (MNTRC)	Rudulph, Kimberly	10/31/15	-
2644	UTC - Spatial Transferability Using Synthetic Population Generation Methods (UCTC)	Chursenoff, David	1/30/16	-
2648	UTC - Accounting for Interregional Travel in Regional Land Use and Transportation Plans: A Comparison of Attribution Methods (UCTC)	Chursenoff, David	1/30/16	-
2643	UTC - Towards Inferring Welfare Changes from Changes in Curbside Parking Occupancy Rates: A Theoretical Analysis Motivated by SFpark and LA Express Park (UCTC)	Chursenoff, David	1/31/16	-
2645	**UTC - Balancing Life-cycle Cost and Life-cycle Impact Considerations in Pavement Management (UCTC)**	**Holland, Joe**	**1/31/16**	**66**
2854	UTC - Traffic Volume and Aggregate Economic Activity: Implications for Taking the Pulse of the U.S. Economy (UCTC)	Chung, Haniel	1/31/16	-
2848	UTC - UCLA ITS Technology Transfer (UCTC)	Tyner, Patrick	2/29/16	-
2641	UTC - Infill Dynamics in Rail Transit Corridors; Challenges and Prospects for Integrating Transportation and Land Use Planning (UCTC)	Iacobucci, Lauren	3/15/16	-
2793	UTC - Demand Forecasting and Activity-based Mobility Modeling from Cell Phone Data (UCCONNECT)	Law, Frank	3/31/16	-
2798	**UTC - Not So Fast: A Study of Traffic Delays, Access, and Economic Activity in the San Francisco Bay Area (UCCONNECT)**	**Alkadri, Mohamed**	**3/31/16**	**68**
2822	**UTC - Environmentally-Friendly Driving Feedback Systems Research and Development for Heavy-Duty Trucks (NCST)**	**Iacobucci, Lauren**	**3/31/16**	**70**
2807	UTC - OCICATS (Online Community Input Classification to Advance Transportation Services) – A GIS-based Decision-Support Tool (UCCONNECT)	Azevedo, Christine	4/1/16	-
2832	**UTC - Urban Spatial Structure and the Potential for VMT Reduction (NCST)**	**Tyner, Patrick**	**4/1/16**	**72**
2799	**UTC - Strategic Charging Infrastructure Deployment for Electric Vehicles (UCCONNECT)**	**Iacobucci, Lauren**	**4/15/16**	**74**
2851	UTC - Business Establishment Survival and Transportation System Level of Service (UCTC)	Tyner, Patrick	4/29/16	-
2797	**UTC - Impacts and Future of the California Fuel Tax Swap of 2010 (UCCONNECT)**	**Williams, Scott**	**4/30/16**	**76**
2869	UTC - Public Transportation and Industrial Location Patterns in California (UCCONNECT)	Provost, Leanne	4/30/16	-
2987	UTC – Three White Papers on emission reducing efficiency strategies to incorporate into the California Sustainable Freight Strategy (NCST)	Azevedo, Christine	5/1/16	-
2988	UTC – Two White Papers on emission reducing efficiency strategies to incorporate into the California Sustainable Freight Strategy (NCST)	Azevedo, Christine	5/1/16	-
2919	UTC - Toward Accurate and Valid Estimates of Greenhouse Gas Reductions from Bikeway Projects (UCCONNECT)	Hunt, Harold	6/30/16	-

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2937	Route Choice Characteristics of Owner-Operated Trucks in Southern California Freeways	Nokes, Bill	9/1/16	-
2641	Infill Dynamics in Rail Transit Corridors; Challenges and Prospects for Integrating Transportation and Land Use Planning	Azevedo, Christine	9/15/16	-
2799	Strategic Charging Infrastructure Deployment for Electric Vehicles	Iacobucci, Lauren	9/30/16	-
2850	California Integrated Border Approach Study (CA-IBAS), Phase 2	Azevedo, Christine	9/30/16	-
2968	Transportation Data Trends and Best Practices	Chursenoff, David	9/30/16	-
2941	The Decline in Inter- and Intra-Urban Mobility and Its Impact on Passenger Travel	Williams, Scott	11/15/16	-
2976	The Effect of State and Federal Housing Policies on Vehicle Miles of Travel	Williams, Scott	11/15/16	-
2797	Impacts and Future of the California Fuel Tax Swap of 2010	Williams, Scott	11/30/16	-
2640	Spatial Dynamics of Warehousing and Distribution in California	Tyner, Patrick	12/31/16	-
2792	Goods Movement and Industrial Land Supply	Tyner, Patrick	12/31/16	-
2939	Developing Affordable Housing Guidelines Near Rail Transit in Los Angeles	Chursenoff, David	12/31/16	-
2891	The Nexus Between Infrastructure and Accessibility	Lao, Kayo	1/31/17	-
2993	The Equity Impacts of California's County Transportation Sales Taxes	Williams, Scott	2/28/17	-
2979	Deployment of Sustainable Fueling/Charging Systems at California Highway Safety Roadside Rest Areas	Williams, Scott	3/15/17	-
2980	Biking in Fresh Air: Consideration of Exposure to Traffic-Related Air Pollution in Bicycle Route Planning	Williams, Scott	3/15/17	-
2999	Workshop and White Paper to Explore the Development of Accessibility, Livability, and Prosperity Scores In Conjunction with Caltrans Planning	Azevedo, Christine	3/15/17	-
2862	Potential Greenhouse Gas Emissions Reductions from Optimizing Urban Transit Networks	Turner, Loren	3/31/17	-
2942	Planning Workshop-Seminar Series	Azevedo, Christine	3/31/17	-
2965	Identifying and analyzing the relative advantages and disadvantages of public-private partnerships and traditional delivery for transport projects	Williams, Scott	3/31/17	-
2967	OHV Fuel Tax Study	Williams, Scott	3/31/17	-
2983	White Paper on the Sustainability of Building Affordable Housing in Transit Oriented Developments (TODs)	Williams, Scott	3/31/17	-
2852	Professional Planner Workforce Development Training Program	Law, Frank	4/1/17	-
2973	Tracking Land Use Changes That Support Sustainable Mobility	Lao, Kayo	4/1/17	-
2886	Shifting from LOS to VMT as the Measure of Transportation Impacts: Evaluating Prospects for Implementing Senate Bill 743	Tyner, Patrick	4/30/17	-
2961	Managing Pedestrian and Car Interactions	Provost, Leanne	4/30/17	-
2963	Long Distance Travel in the California Household Travel Survey (CHTS) and Social Media Augmentation	Williams, Scott	4/30/17	-
2974	The Impact of Residential Location, Lifestyles and Emerging Technologies on the Travel Behavior and Vehicle Ownership of Young Adults ("Millennials") in California	Tyner, Patrick	4/30/17	-
2985	Enabling Demand Modeling from Privately Held Mobility Data	Williams, Scott	4/30/17	-
3007	Mapping and Improving the Delivery Process of Highway Pavement Rehabilitation Projects	Provost, Leanne	4/30/17	-
2918	The Effectiveness of State and Local Incentives on Household Ownership of Alternative Fuel Vehicles – A SEM Analysis	Azevedo, Christine	6/30/17	-

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3142	Framework for Developing Economic Competitiveness Measures for the California Sustainable Freight Action Plan	Tyner, Patrick	7/15/17	-
2833	Transit Oriented Development and Commercial Gentrification: Exploring the linkages	Williams, Scott	8/15/17	-
2856	Policy Forums	Azevedo, Christine	9/30/17	-
2857	Research In Action On-line Engagement	Azevedo, Christine	9/30/17	-
3081	Evaluating Freight Efficiency Metrics	Tyner, Patrick	9/30/17	-
3073	White Paper on the Economic Benefits of Placemaking: Transportation Implications	Williams, Scott	10/31/17	-
3089	Truck Choice Modeling: Understanding California's transition to ZEV trucks taking into account truck technologies, costs, and fleet decision behavior	Tyner, Patrick	10/31/17	-
3092	Development and Application of an Integrated Health Impact Assessment Tool for Transportation Plans in Sacramento County	Provost, Leanne	10/31/17	-
3132	Caltrans Freight Program Assessment Initiative	Tyner, Patrick	11/30/17	-
3133	Managing the Impacts of Freight in California	Tyner, Patrick	11/30/17	-
3118	Caltrans Future of Mobility White Paper	Azevedo, Christine	1/31/18	-
3123	Evaluating Economic Mobility and Resilience of Multimodal Freight Operations in a Connected Vehicle Environment	Tyner, Patrick	2/28/18	-
3088	The Impact of Shared Mobility on the Use of Other Transportation Modes and Auto Ownership among Millennials and Middle-aged Adults in California	Lao, Kayo	3/31/18	-
3090	Development of a Freight System Conceptualization and Impact Assessment (Fre-SCANDIA) Framework	Tyner, Patrick	3/31/18	-

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2847	State Responses to Energy Sector Developments, TPF-5(327)	Tyner, Patrick	8/31/16	-
2782	Toolkit for the Deployment of Alternative Vehicle and Fuel Technologies, TPF-5(331)	Tyner, Patrick	3/30/18	-
2620	Western Road Usage Charging Consortium (WRUCC), TPF-5(288)	Williams, Scott	3/31/18	-

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2777	**Precision Mapping of the California Connected Vehicle (CV) Test-Bed Corridor**	**Siddiqui, Asfand**	**9/30/15**	**78**
3010	Work Zone Intrusion Alarms for Highway Workers	Unck, Justin	8/1/16	-
2495	Traffic Management Center (TMC) Training Simulator Upgrade and Support Right of Way and Land Surveys	Slonaker, John	3/31/17	-

Right of Way and Land Surveys

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2996	Research and Support for MTLS Data Management and Visualization	Lofton, Arvern	9/30/16	-
2729	Expanding Mobile Terrestrial Laser Scanning (MTLS) Capability and Capacity throughout Caltrans	Lofton, Arvern	2/14/17	-

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1747	Professional Capacity Building for Communication Systems Phase III: Telco Wireless Communications	Perez, Jose	12/29/15	-
1846	**Responder Study Phase III: Enhancements, Specifications and Deployment**	**Clark, Melissa**	**12/31/15**	**80**
2283	WeatherShare Phase III: Visualization Tools	Campbell, Sean	12/31/15	-
1753	COATS Phase VI	Campbell, Sean	6/30/16	-

Rural TPF

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2246	Western States Rural Transportation Consortium (WSRTC), TPF-5(241)	Campbell, Sean	6/30/16	-
2916	WeatherShare Phase IV - Inclement Weather Testing, TPF 5(241)	Campbell, Sean	9/30/17	-
1760	Rural Traveler Information Needs Assessment and Pilot Study Phase III: Bordering States Rural Coverage, TPF-5(241)	Campbell, Sean	2/28/18	-

Seismic

Task ID	Task Title	Task Manager	End Date	Page #
2420	**Seismic Assessment of Cut and Cover Tunnels**	**Sikorsky, Charles**	**7/31/15**	**82**
2263	**Evaluation and Improvement of Design Methods and Details for Shear Keys and Stem Walls in Bridge Abutments**	**Sikorsky, Charles**	**9/30/15**	**84**
2563	**A706 Grade 80 Reinforcement for Seismic Applications**	**Sikorsky, Charles**	**9/30/15**	**86**
2582	Omni-directional Hysteretic p-y Models for Piles Embedded in Cohesive Soils	Sikorsky, Charles	9/30/15	-
2287	Analytical and Experimental Development of Bridges with Foundations Allowed to Uplift during Earthquakes	Lee, Peter	10/31/15	-
2423	**Seismic Performance of Bridge Column-Pile-Shaft Pin Connections for Application in Accelerated Bridge Construction**	**Lee, Peter**	**11/30/15**	**88**
2560	**Development Length for Headed Rebar in Slab Bridges**	**Sikorsky, Charles**	**1/31/16**	**90**
2173	Impact of Inspection Tube Placement on Structural Performance of CIDH Piles	Sikorsky, Charles	4/30/16	-
2562	Evaluation of Durability and Wear Characteristics of Viscous Fluid Dampers	Sikorsky, Charles	4/30/16	-
2756	Calibration of Probabilistic Damage Control Approach (PDCA) for Seismic Design of Bridges - Phase II	Lee, Peter	12/31/16	-
2754	Development of Validated Methods for Soil-Structure Interaction Analysis of Buried Structures	Lee, Peter	5/31/17	-
2744	Numerical Assessment of Liquefaction-induced Ground Deformations and Loading Mechanisms	Sikorsky, Charles	6/30/17	-
2755	Efficient Nonlinear Time History Analysis of California Bridges	Sikorsky, Charles	6/30/17	-
2880	Development of Performance-Based Seismic Design Guidance for Ordinary Bridges	Sikorsky, Charles	7/31/17	-
2544	Seismic Performance of Bridge Superstructure in Accelerated Bridge Construction	Lee, Peter	8/14/17	-
2881	Next-Gen Monitoring and Evaluation of California Bridges	Sikorsky, Charles	9/30/17	-
2861	A Comprehensive Set of Testing Protocols for Buckling-restrained Braces Applied to Bridges	Sikorsky, Charles	11/30/17	-
2522	Cyclic Performance Characterization of Large Diameter Steel Reinforcing Bars and Mechanical Couplers	Sikorsky, Charles	1/31/18	-
2539	Experimental Validation of Interaction of MSE Abutments with Superstructures under Seismic Loading	Sikorsky, Charles	1/31/18	-

Seismic (continued)

Task ID	Task Title	Task Manager	End Date	Page #
2561	Seismic Assessment of Cut and Cover Tunnels - Large Scale Tests	Sikorsky, Charles	4/30/18	-
2879	Development of a Validated Methodology for Seismic Analysis and Design of Standard and Pile Supported Retaining Walls	Lee, Peter	5/31/18	-
2994	Seismic Behavior of Grade 80 RC Bridge Columns - Phase 1	Sikorsky, Charles	6/29/18	-

Strategic Planning TPF

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2745	2015 Performance Measures Technical Transfer Conference and Asset Management Peer Exchange, TPF-5(303)	Williams, Scott	9/30/16	-

Transportation Safety and Mobility

Task ID	Task Title	Task Manager	End Date	Page #
2839	**Travel Time Detector Installation and Integration in District 3**	**Slonaker, John**	**8/1/15**	**92**
2529	**Advanced Traffic Signal Control Algorithms, Phase 2**	**Siddiqui, Asfand**	**8/31/15**	**94**
2449	**Queue Storage and Acceleration Lane Length Design at Metered On-ramps in California**	**Perez, Jose**	**10/31/15**	**96**
2815	UTC - Tracking Truck Flows with Programmable Mobile Devices (METRANS)	Mizuno, Bradley	10/31/15	-
2813	**UTC - Mitigating Urban Freight through Effective Management of Truck Chassis (METRANS)**	**Hanson, Matt**	**12/31/15**	**98**
2816	UTC - Analysis and Prediction of Spatiotemporal Impact of Traffic Incidents for Better Mobility and Safety in Transportation Systems (METRANS)	Clark, Melissa	12/31/15	-
2818	**UTC - A Dynamical Framework for Integrated Corridor Management (METRANS)**	**Perez, Jose**	**12/31/15**	**100**
2836	Development of a Plan to Collect Bicycle Infrastructure and Volume Data for Future Incorporation into TASAS-TSN	Loebs, Nathan	1/30/16	-
2810	**UTC - Control Strategies for Corridor Management (UCCONNECT)**	**Perez, Jose**	**2/29/16**	**100**
2801	**UTC - Bicycle Crash Risk: How Does It Vary and Why (UCCONNECT)**	**Loebs, Nathan**	**3/31/16**	**102**
2826	UTC - Bicyclist Behavior in San Francisco: A Before-and-After Study of the Impact of Infrastructure Investments (NCST)	Loebs, Nathan	4/1/16	-
2846	One California Proposal for FHWA's CV Pilot Deployments	Sah, Prakash	4/17/16	-
2872	UTC - SB-743: From LOS to VMT, VHT and Beyond Through Data Fusion: Application to Integrated Corridor Management (UCCONNECT)	Wang, Yue	4/30/16	-
2844	UTC - Performance Measures for Bicycle Suitability on the State Highway System, (UCCONNECT)	Loebs, Nathan	5/30/16	-
2871	**UTC - What Can a Bike Lane Do? Performance Metrics for Proposed Bicycle Infrastructure (UCCONNECT)**	**Kwong, Jerry**	**5/31/16**	**104**
2446	Development of Safety Performance Functions for California -Type 2, Advanced	Kwong, Jerry	6/29/16	-
2804	UTC - Experimental Studies for Traffic Incident Management (UCCONNECT)	Clark, Melissa	6/30/16	-
2915	HOT Lane Calibration and Simulation Algorithms	Mizuno, Bradley	8/31/16	-
2837	Assist in the Development and Testing of the Connected Corridors I-210 Pilot Project (In-House Research)	Slonaker, John	10/10/16	-
2839	Travel Time Detector Installation and Integration on US 50 in District 3	Slonaker, John	10/14/16	-
2977	Dynamic Ridesharing: Simulation of System-Level Travel Effects Using Agent-Based Demand and Supply Models in the Sacramento Region	Tyner, Patrick	12/30/16	-
2841	Testing MS Sedco INTERSECTOR Radar Detectors for Car/Bike Differentiation	Slonaker, John	12/31/16	-

Transportation Safety and Mobility (continued)

Task ID	Task Title	Task Manager	End Date	Page #
2531	Automated Video Incident Detection (AVID) System	Slonaker, John	1/11/17	-
2912	Cell Transmission Model (CTM)-based Optimal Signal Control Strategies in Urban Networks	Chung, Haniel	1/30/17	-
2450	Phase 2: Strategies for Reducing Pedestrian and Bicyclist Injury at the Corridor Level (SMART)	Kwong, Jerry	1/31/17	-
2876	A Unified Framework for Analyzing and Designing Signals for Stationary Arterial Networks	Chung, Haniel	1/31/17	-
3079	Examining the Safety, Mobility and Environmental Sustainability Co-Benefits and Tradeoffs of Intelligent Transportation Systems	Tyner, Patrick	2/28/17	-
2975	Warehousing and Distribution Center Facilities in Southern California: The Use of the Commodity Flow Survey Microdata to Identify Logistics Sprawl and Freight Generation Patterns	Tyner, Patrick	3/31/17	-
2959	Traffic Predictive Control	Provost, Leanne	4/30/17	-
3001	Sustainable Operation of Arterial Networks	Perez, Jose	4/30/17	-
2911	Evaluating Deployability of Cooperative Adaptive Cruise Control (CACC) to Form High-Performance Vehicle Streams — Cost Share	Siddiqui, Asfand	6/30/17	-
2646	An Evaluation of Signalized Intersection Safety Using Centracs System	Gwynne, Gloria	7/31/17	-
2770	Experimental Studies of Traffic Incident Management with Pricing, Private Information, and Diverse Subjects	Clark, Melissa	7/31/17	-
2984	Congestion Reduction through Efficient Empty Container Movement	Tyner, Patrick	8/14/17	-
2652	Adaptive Coordination Algorithm for Arterial Traffic Signals	Slonaker, John	9/30/17	-
2899	Identify the Data Requirements for Safety Screening to Identify High Collision Concentration Locations	Kwong, Jerry	9/30/17	-
2906	TASAS (Traffic Accident Surveillance and Analysis System) and Injury Data Base Development	Ikram, Hamid	9/30/17	-
3096	Evaluating the Environmental Impact of Traffic Congestion in Real Time Based on Sparse Mobile Crowd-sourced Data	Provost, Leanne	10/31/17	-
2660	Coordination of Freeway Ramp Meters and Arterial Traffic Signals (Phase IIB); Field Operational Test	AbouKhadijeh, Hassan	11/30/17	-
2447	Combined Variable Speed Limit and Coordinated Ramp Metering for Freeway Traffic Control: Field Test of Variable Speed Advisory (VSA) for Freeway Traffic Control	AbouKhadijeh, Hassan	12/15/17	-
2564	Assist in the Development and Support of an Enterprise-Wide Traveler Information System	Campbell, Sean	12/31/17	-
2995	Connected Corridor Research for I-210 Corridor Management	Slonaker, John	12/31/17	-
2452	Phase 2: Pedestrian Safety Improvement Program Development	Kwong, Jerry	1/31/18	-
3139	Investigation of Multimodal Crashes using Full Bayesian Multivariate Spatial-Temporal Models	Kwong, Jerry	2/28/18	-
3140	Control and Management of Urban Traffic Networks with Mixed Autonomy	Perez, Jose	2/28/18	-
2464	Trip-Generation Rates for Smart Growth Land Use Projects	Gwynne, Gloria	3/31/18	-
2970	Vision-based Sensor System for Site Monitoring: Wrong-Way Driving, Phase 1	Slonaker, John	3/31/18	-
2465	Affordable Housing Trip Generation Strategies and Rates	Gwynne, Gloria	4/30/18	-
2950	Maintenance, Operations and Enhancement of DSRC Communications Infrastructure	Siddiqui, Asfand	4/30/18	-
3094	Automated Vehicle Scenarios: Simulation of System-Level Travel Effects Using Agent-Based Demand and Supply Models in the San Francisco Bay Area	Tyner, Patrick	5/15/18	-
3109	Modeling and Control of HOT lanes Phase II	Siddiqui, Asfand	6/30/18	-

Transportation Safety and Mobility TPF

Task ID	Task Title	Task Manager	End Date	Page #
0230	Traffic Management Center (TMC) Consortium; SPR-2(207) and TPF-5(052)	Clark, Melissa	7/1/16	-
2061	Support for Research and Deployment of System Ops Applications of VII, TPF-5(206)	Siddiqui, Asfand	12/31/16	-
2318	Highway Safety Manual Implementation, TPF-5(255)	Kwong, Jerry	12/31/16	-
0788	Traffic Control Devices, TPF-5(065) and TPF-5(316)	Perez, Jose	5/1/17	-
2306	Traffic Signal Systems Operations and Management, TPF-5(258)	Clark, Melissa	6/30/17	-
0797	Evaluation of Low Cost Safety Improvements, TPF-5(099) (ELCSI PFS) and TPF-5(317)	Loebs, Nathan	12/31/17	-
1057	Texas Transportation Institute (TTI) Roadside Safety Research Program, TPF-5(114)	Jewell, John	6/29/18	-

Fiscal Year 2015/16
Research Results

For this report, DRISI selected a variety of research tasks that highlight elements of the research program. The research results are organized by topic area and provide a high-level summary of the research need, goal, methodology, outcome, and benefit. These documents were produced with the collaboration of the participants of the tasks.

You can download the summaries from *www.dot.ca.gov/research/researchreports/technical_summaries.htm.* For more information about a specific task, contact the task manager listed.

DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Testing Vehicle-to-Vehicle Communications in Mixed Traffic Environments

Truck convoys offer many advantages, but how do they perform when passenger vehicles are present?

Advanced Research

APRIL 2017

Project Title:
Vehicle-to-Vehicle Communications in Mixed Passenger – Freight Convoys

Task Number: 2819

Start Date: January 1, 2015

Completion Date: December 31, 2015

Product Category: New or improved decision support tool, simulation, model, or algorithm

Task Manager:
Asfand Siddiqui
Transportation Engineer
asfand.siddiqui@dot.ca.gov

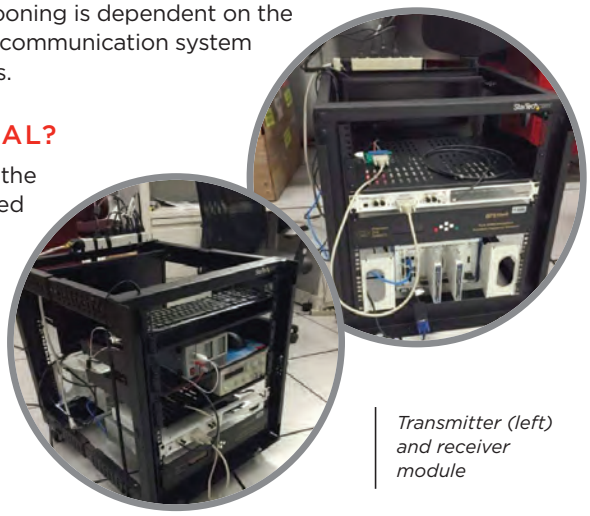
WHAT IS THE NEED?

Transporting freight in California depends on trucks moving goods from terminals to warehouses and between distribution centers. But trucks also pose major traffic and safety challenges. Accidents involving trucks are more deadly, and traffic congestion is more likely when the flow of trucks is high, especially in the vicinity of ports. Controlled truck convoys, or platooning, can help address these concerns and offers a multitude of advantages. Vehicles in a convoy can keep shorter distances between each other, achieving higher traffic density as well as reducing wind drag, which improves fuel efficiency. The probability of accidents can be reduced when the speed of the convoy is uniform, and drivers are less fatigued when constant lane changes are eliminated.

A key requirement for platooning is automated control of the distance between the participants via reliable and low-latency communications. The IEEE 802.11p wireless vehicular communication system has emerged as the international standard, and its performance between passenger cars has been widely studied. There is minimal large-scale field testing with 802.11p-compliant devices in terms of how the propagation channel is affected when signals between passenger vehicles are blocked by trucks, yet implementing truck platooning is dependent on the performance of the wireless communication system in mixed traffic environments.

WHAT WAS OUR GOAL?

The goal was to investigate the performance of 802.11p-based wireless communication systems for mixed-traffic environments and assess the impact on convoy formation.



Transmitter (left) and receiver module

Caltrans

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Testing Vehicle-to-Vehicle Communications in Mixed Traffic Environments

Research Results

WHAT DID WE DO?

Caltrans, in partnership with the METRANS Transportation Center, measured truck-to-vehicle and truck-to-truck propagation channels in various scenarios and environments in the Los Angeles area, along busy urban boulevards lined with tall buildings, multilane freeways guarded with concrete walls and sound barriers, and less congested, landscaped neighborhood streets. Based on the collected data, researchers at the University of Southern California created a simulation platform of the 802.11p physical layer and developed equipment, such as a channel sounder and multiple antenna arrays, to evaluate the performance of conforming radios in the vehicle-to-vehicle propagation channels. They assembled a comprehensive database of measured propagation channel characteristics for mixed traffic convoy scenarios, including descriptions of the measurement environments, the types of vehicles and their antenna arrangements, distances between the vehicles, line-of-sight situations, and received powers and impulse responses.

WHAT WAS THE OUTCOME?

The placement of the antenna on the driver truck cabin roof affects communication due to the trailer's metallic material and height. The intrinsic geometry of the truck can obstruct the line of sight between the transmitting and receiving trucks when they are traveling in convoy in the same direction or act as a reflector when the vehicles are traveling in opposite directions.

Server racks holding the equipment

WHAT IS THE BENEFIT?

Vehicle-to-vehicle communications is central to enabling efficient and safer transportation. Truck platooning could lead to less congestion, fewer accidents, and reduced fuel consumption. The tools developed in this research enhance the understanding of how 802.11p behaves in mixed traffic environments, particularly when large trucks are present that can block radio pathways, and provide a methodology to improve the design of existing control systems and promote the development of policies and technologies for convoy formation.

LEARN MORE

To view the complete report:
www.metrans.org/sites/default/files/research-project/METRANS_Vehicle_to_Vehicle_Communications_in_Mixed_Passenger_Freight_Convoys.pdf

Receiver array on top of the vehicle

Transmitter antenna on top of the vehicle

DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Slow Down: Is Photo Speed Enforcement in Work Zones the Answer?

Although PSE technology can capture data, it might not be the ticket to reduce speeding

Construction

DECEMBER 2016

Project Title:
Evaluation of Photo Speed Enforcement (PSE) in California Work Zones

Task Number: 2405

Start Date: May 31, 2012

Completion Date: September 30, 2015

Product Category: Evaluation of new commercial products to determine whether they meet Caltrans needs

Task Manager:
Sukhdeep Nagra
Transportation Engineer
sukhdeep.nagra@dot.ca.gov

WHAT WAS THE NEED?

Speeding in highway work zones is an ongoing concern, affecting both the safety of workers and the traveling public. To get drivers to slow down, some states have adopted automated photo speed enforcement (PSE) technology. Before deploying PSE in California, Caltrans needed to evaluate existing practices, available technologies, and perform testing to establish guidelines and enforcement.

WHAT WAS OUR GOAL?

The goal was to evaluate PSE technologies, current implementations, and whether the technology would be effective in reducing speeding in California highway work zones.

Test facility with the location of PSE cameras

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Slow Down: Is Photo Speed Enforcement in Work Zones the Answer?

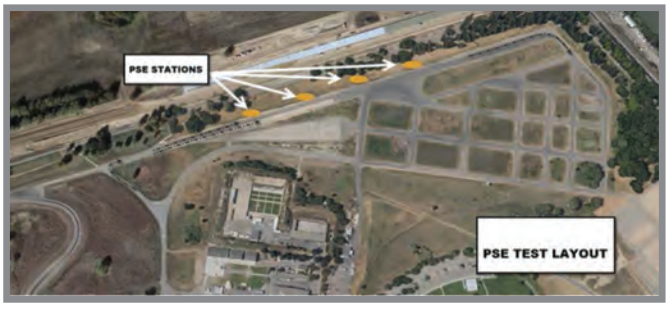
WHAT DID WE DO?

To determine the effectiveness of PSE systems, Caltrans first reviewed the various implementations and applications in others states to glean what lessons could be learned from their experiences. After testing several PSE technologies in a controlled environment to understand the operational conditions and limitations, the researchers field-tested three different systems in active California work zones. Three PSE technology vendors participated and provided their personnel and equipment. The test sites were chosen in coordination with the California Highway Patrol (CHP). In Stockton, two traffic lanes were evaluated, and four lanes were tested in the Los Angeles area. The researchers then analyzed the data collected to assess the magnitude of the speeding problem and understand the limitations and capabilities of PSE technologies.

WHAT WAS THE OUTCOME?

The Stockton test results indicated that 500 to 1,000 vehicles were speeding during the midnight to morning shift. In the morning and afternoon shifts, the number grew to between 1,000 and 1,200. In the Los Angeles area, the numbers ranged from 700 to 2,000 vehicles in the midnight shift, up to 2,000 in the afternoon shift, and up to 3,500 in the morning shift. Considering that the sensors were not able to capture all speeding vehicles in each lane or from unobserved lanes, the data illustrates the magnitude of the speeding problem in the work zones.

The PSE systems were able to capture photos of about 60% of the speeding vehicles in a given lane. Pictures are not taken if the quality is not good enough. For a fully citable event, both the license plate and driver must be identifiable. Some images were not clear, and some had obstructions due to a sun visor or driver's sunglasses. Citable events were below 50% for all PSE equipment tested. Although the percentage of citable events was relatively low, the number of events captured in any given period of time far exceeded the numbers handled by on-duty police officers pursuing speeding drivers. For example, the number for Stockton during the morning shift is between 23–52 citations per hour. In Los Angeles, the range is 5–13 citations per hour. However, the CHP has recommended not to implement PSE based on a number of concerns, including judicial handling of citable events based on existing laws, the impact of the much higher volume of citations on the judicial system, and the lack of data on public acceptability of the use of PSE technology for work zone speed enforcement.



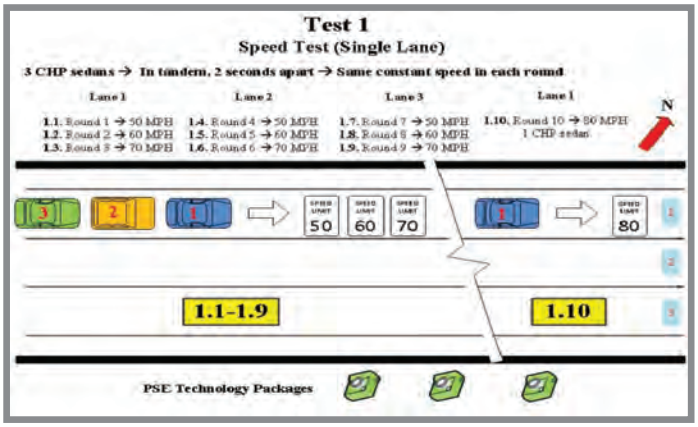
Positions of the PSE stations in the straight section of the test track

WHAT IS THE BENEFIT?

Speeding through highway work zones is a major issue. Adherence to speed limits would reduce the number and severity of collisions. The study identified the capabilities of PSE technology and the advantages and disadvantages it offers and determined the availability of commercial systems that can be easily deployed in work zones. Before California adopts a PSE system, the impact on other stakeholders needs to be considered, such as the ticketing process and courts systems, and the resources necessary to manage the increased volume generated.

LEARN MORE

To view the complete report:
www.dot.ca.gov/newtech/researchreports/reports/2015/CA15-2405_FinalReport.pdf



Single-lane speed detection test series

DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Designing an Aesthetic, Low-Maintenance Guardrail

A new concrete foundation design provides a footing for more attractive guardrail alternatives

Design

DECEMBER 2016

Project Title:
Development of Aesthetic, Low-Maintenance Guardrail System Alternatives

Task Number: 0918

Start Date: September 1, 2005

Completion Date: November 10, 2015

Product Category: New or improved technical standard, plan, or specification

Task Manager:
Christopher Caldwell
Transportation Engineer, Civil
christopher.caldwell@dot.ca.gov

WHAT WAS THE NEED?

The most commonly used guardrail in California is a metal beam, often referred to as a W-beam guardrail because the steel coil is rolled into the shape of a "W." Although the guardrail's design has proven effective in redirecting errant vehicles and minimizing vehicle damage, it loses its effectiveness after a severe impact and is expensive to repair. Replacing damaged sections exposes Caltrans maintenance crews to traffic hazards and creates traffic delays. In addition to maintenance and cost issues, many communities and agencies are requesting that the unattractive metal beam guardrails be replaced with roadside barriers that are more aesthetically conducive to the surrounding environment. The current guardrail system obscures and detracts from the scenic views along California's coastal and rural highways. However, only a limited number of aesthetic barriers meet the Test Level 3 criteria of the older National Cooperative Highway Research Program (NCHRP) Report 350 crash testing guidelines and the current Manual for Assessing Safety Hardware (MASH) guidelines, and most are proprietary and expensive to build and maintain.

WHAT WAS OUR GOAL?

This goal was to develop an aesthetic, crashworthy, low-maintenance guardrail system that preserves views and protects the public.

Completed barrier construction, back and front

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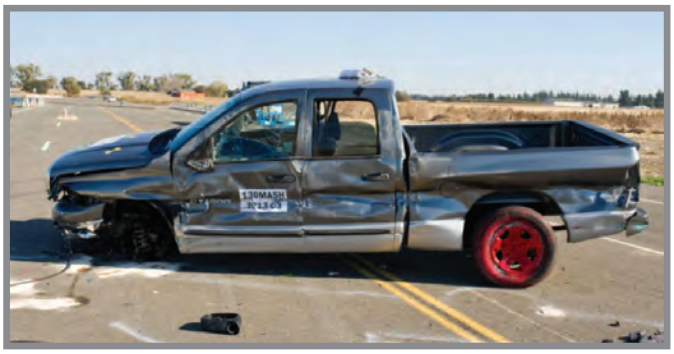
WHAT DID WE DO?

Caltrans developed a concrete footing that can be combined with an aesthetically pleasing bridge rail. The Roadside Safety Research Group conducted a MASH 3-11 test on the ST-10 bridge rail mounted on a 30-inch deep by 20-inch wide concrete trench footing foundation. To create the worst-case scenario, the barrier was installed in weak soil with a 3:1 slope cut out behind the barrier. The slope starts 3 feet from the back edge of the concrete footing with a depth equal to the footing's depth. The footing was placed in two parts, first the footing and then the 6-inch curb, creating a cold construction joint between them. The test vehicle, a 2006 Dodge Ram 1500 Quad Cab pickup truck, hit the barrier at 62 miles per hour and an angle of 24.7 degrees.

Vehicle impacting the barrier



Damage to the vehicle

WHAT WAS THE OUTCOME?

The combination of the ST-10 bridge rail and trench footing successfully redirected the vehicle, and the damage to the barrier was only cosmetic. However, the entire driver side of the vehicle was damaged, and the front driver side tire and hub assembly broke off during impact. After the vehicle lost contact with the barrier, it rolled onto its side. Although the barrier failed the MASH evaluation criteria, the trench footing functioned well and had negligible movement. Therefore, the trench footing is recommended for use with rigid bridge rail designs that have met either NCHRP Report 350's or MASH's Test Level 3 or Test Level 4 criteria. However, because the testing was performed only up to MASH Test Level 3, only barriers meeting that criteria should be considered.

WHAT IS THE BENEFIT?

California communities want crashworthy guardrail options that are architecturally pleasing, fit more harmoniously with the setting, and preserve existing views. It is also critical to have a low-maintenance guardrail system to decrease the amount of time crews are at risk of injury while repairing damaged guardrails and lessen the time the traveling public is subject to traffic delays during repairs. Caltrans has developed a trench footing that can be combined with an aesthetic rail, providing local agencies with alternatives to the metal beam guardrail.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2015/CA15-0918_FinalReport.pdf

Damage to the barrier

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Caltrans Division of Research, Innovation and System Information

Research Results

Why Didn't the Coyote Cross the Road?

Highways can limit wildlife movement, affecting genetic diversity

Environmental

DECEMBER 2016

Project Title:
Do California Highways Act as Barriers to Gene Flow for Ground-Dwelling Mammals?

Task Number: 2824

Start Date: September 23, 2014

Completion Date: April 15, 2016

Product Category: New or improved manual, handbook, guidelines, or training

Task Manager:
Harold Hunt
Senior Environmental Planner
harold.hunt@dot.ca.gov

WHAT WAS THE NEED?

State and federal environmental and transportation statutes support and require actions that minimize impacts from construction and operation of transportation systems, including disruption of wildlife gene flow. Road-induced genetic divergence among vertebrates has been documented, with the effect varying based on the type of road and use. If animals have limited movement in their typical range, the divided populations can become genetically different from each other, which can jeopardize the survival of populations and even entire species. Carnivores are especially vulnerable to population division by highways because they have large movement requirements as they seek prey.

To help animals to safely traverse roads, expensive mitigation measures are built, such as culverts and under- and over-crossings. Yet movement and gene flow vary by road and species, so choosing the appropriate cost-effective solution requires understanding the population's biology and local distribution. Additionally, it is often difficult to validate the success of mitigation measures. Recent advances in gene sequencing and bioinformatics have made it practical to use genomics in transportation applications. For example, the cost of gene sequencing has plummeted dramatically in the past decade. Using DNA techniques with environmental samples can help Caltrans determine whether mitigation is needed, where, and which type.

WHAT WAS OUR GOAL?

The goal was to determine whether major highways disrupt connectivity of coyote populations.

Coyote at culvert entrance for passage under I-280

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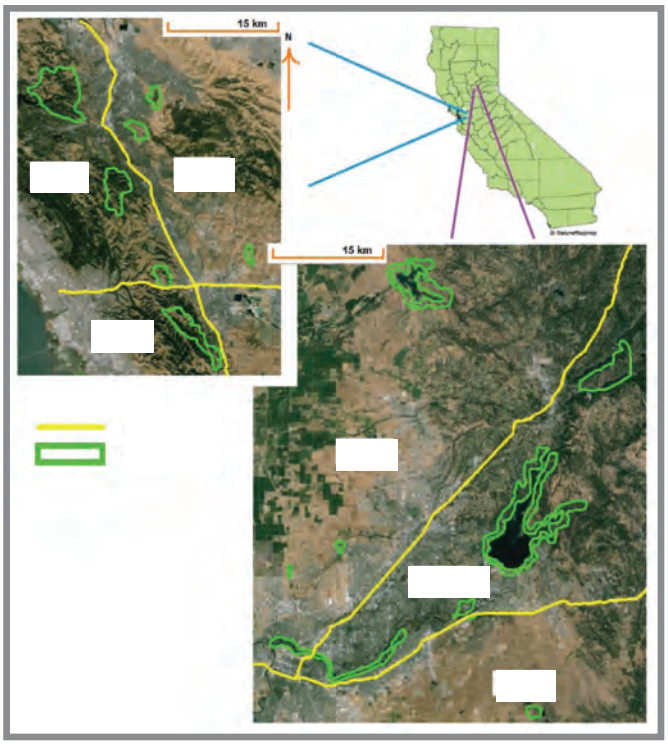
Why Didn't the Coyote Cross the Road?

Research Results

WHAT DID WE DO?

Caltrans, in partnership with the National Center for Sustainable Transportation, examined the potential effects of Northern California highways on coyote populations. The researchers from University of California, Davis chose coyotes because they are abundant, wide-ranging, and use many habitat types. Research has shown that Southern California highways can impede gene flow of numerous types of wildlife, but few studies have investigated the effect of Northern California highways. Genetic samples from road-killed coyotes and noninvasive sources (hair and scat) were collected from both sides of highways SR 50 and I-80 in the Sierra Nevada foothills, and I-580 and I-680 in the San Francisco Bay Area. The researchers used landscape genetic analyses to determine whether these highways acted as barriers to gene flow and how genetic diversity is partitioned. Population assignment tests were used to infer the number of populations and identify migrants dispersing across highways. The project developed maps indicating the highway segments represented by the field sampling of genetic material.



Study areas in the San Francisco Bay Area and Sierra Nevada foothills in which coyote sampling occurred

WHAT WAS THE OUTCOME?

In contrast to findings in Southern California across U.S. 101, the study observed high levels of genetic diversity in coyotes in both regions and little evidence of genetic structuring across the highways, suggesting that these highways are not currently limiting gene flow. One possible explanation is successful road crossings or the use of crossing structures. Alternatively, the highways in the study areas might not have been in place long enough to produce detectable signals of genetic structuring in a genetically diverse, large-bodied, wide-ranging species like coyote. Therefore, genetic structuring could be occurring among other animals, such as endangered species with low genetic diversity or small-bodied wildlife less capable of successful road crossing.

WHAT IS THE BENEFIT?

During transportation project development and maintenance, Caltrans must consider the well-being of surrounding wildlife. To plan appropriate mitigation solutions, it is important to determine which roads to target and which species are most affected because the impacts of roads on wildlife gene flow cannot be generalized based on the infrastructure or among species. More affordable DNA techniques can help agencies determine whether and where mitigation measures are needed to cost-effectively reduce the impact of transportation on the native wildlife population.

LEARN MORE

For more information:
roadecology.ucdavis.edu/research/projects/do-california-highways-act-barriers-gene-flow-ground-dwelling-mammals

ncst.ucdavis.edu/wp-content/uploads/2014/08/05-17-2016-NCST_Brief_ITSSchreier_FINAL_v2.pdf

DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Using In-vehicle Data Acquisition Systems to Manage Fleet Usage and Costs

An in-vehicle data acquisition system can help save fuels costs and reduce emissions when partnered with policy directives

Equipment

DECEMBER 2016

Project Title:
Light Fleet In-vehicle Data Acquisition System (FIDAS) Evaluation

Task Number: 2516

Start Date: April 1, 2012

Completion Date: September 30, 2015

Product Category: Evaluation of new commercial products to determine whether they meet Caltrans needs

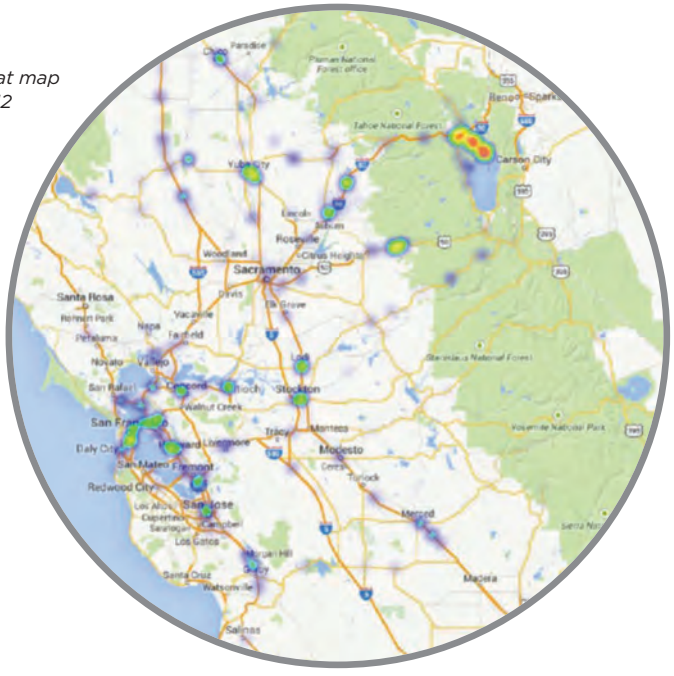
Task Manager:
Jose Perez
Transportation Engineer, Electrical
jose.perez@dot.ca.gov

WHAT WAS THE NEED?

With a fleet of about 7,100 lightweight vehicles and 2,000 heavy vehicles, Caltrans needs a cost-effective tool to streamline operations, track usage and costs, and reduce vehicle emissions. Automated Vehicle Location systems using GPS to manage large vehicle fleets have been well-tested in both the private and public sectors. Recent technological advancements have lowered the cost of these systems and improved their data collection ability. Fleet in-vehicle data acquisition systems (FIDAS) take advantage of the on-board diagnostic port that is now available in newer vehicles, facilitating data collection beyond just location, such as detecting unsafe driving behavior and monitoring servicing needs.

WHAT WAS OUR GOAL?

The goal was to find a cost-effective, commercial solution to manage the Caltrans vehicle fleet and reduce fuel costs.



Idling location heat map for December 2012

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Using In-vehicle Data Acquisition Systems to Manage Fleet Usage and Costs

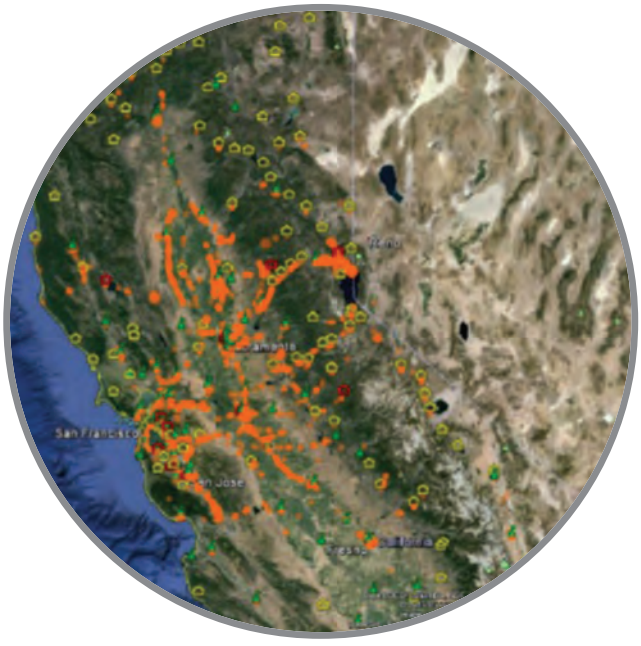
Research Results

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Davis Advanced Highway Maintenance and Construction Technology Research Center, evaluated state-of-the-art methods and devices for fleet tracking, installed telematics devices in 200 light vehicles as part of a pilot study, assessed areas for potential improvements and savings, and performed a cost-benefit analysis. Two different deployment options were analyzed: cellular and Wi-Fi. During the time of the study, the average price for regular gasoline was $3.87. A $4.00 per gallon fuel price was used for the cost-benefit analysis. The analysis also included a yearly $0.18 per gallon increase in fuel prices. The researchers developed algorithms to identify waste and inefficiency in the fleet.

WHAT WAS THE OUTCOME?

Based on the data collected, 13% of vehicle fuel is squandered on idling, and 2% is wasted due to speeding. Eliminating 95% of speeding and idling would result in a 12% fuel savings, approximately $39.60 per vehicle per month. Although the analysis depended on many variables that can significantly affect the results, the fuel price alone can change the payback duration. To break even within five years at $4 per gallon, a minimum of 12% fuel savings must be achieved for the cellular option, and a minimum of 8% reduction for the Wi-Fi solution. To save costs, the FIDAS solution could be implemented in vehicles with large engines and low miles per gallon and not used with hybrids, which often turn off when idling for a long period. The study also found that, despite claims from FIDAS solution providers, equipment alone does not change driver behavior. To accomplish true fuel savings, a new policy on idling and speeding must be established and enforced with training, coaching, and positive incentives. Installing FIDAS telematics devices without changing driver behavior does not lead to cost savings.



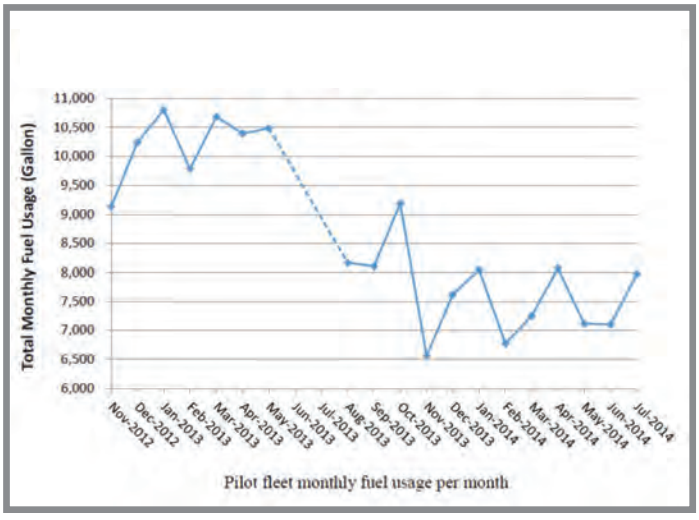
Idling location cluster map for January 2014 for Northern California, from Google Earth

WHAT IS THE BENEFIT?

A FIDAS solution could pay for itself with the resulting fuel savings from reduced idling and speeding, which also lowers greenhouse gas emissions. Beyond lowering fuel costs, a FIDAS offers several benefits. Monitoring speeding and unsafe driving behavior reduces the associated risks and wear and tear. The system can help decrease unauthorized use, automate smog checks, and keep track of maintenance schedules.

LEARN MORE

To view the complete report:
ahmct.ucdavis.edu/pdf/UCD-ARR-15-09-30-02.pdf



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Research Results

Eliminating Hinge Curl in Bridge Joints During and After Construction

Accurately predicting the deformation of in-span hinges to create a smooth transition between bridge frames reduces costs and construction delays

Geotech/ Structures

DECEMBER 2016

Project Title:
Time Dependent Deflection of In-Span Hinges of Prestressed Concrete Structures During Construction

Task Number: 1946

Start Date: July 11, 2011

Completion Date: August 31, 2015

Product Category: New or improved technical standard, plan, or specification

Task Manager:
Hamid Ikram
Transportation Engineer
hamid.ikram@dot.ca.gov

WHAT WAS THE NEED?

Cast-in-place, post-tensioned concrete box girder highway bridges are widely used in California. Typically, these bridges are long and must be divided into frames that are joined with in-span hinges, which require special design considerations to ensure a smooth road surface between the bridge frames for a safe and comfortable ride. During and after construction, many bridges have experienced hinge curl—a condition where the two sides of the hinge have different elevations, creating a bump in the road that presents a potential road hazard to the traveling public. To avoid the adverse effects of mismatched joints, Caltrans developed a method to estimate deformations to minimize hinge curl, which is documented in memo to designer (MTD) 11-34. However, the estimates produced with this method do not always have the same outcome in the field, resulting in unanticipated hinge curl. To correct the grade differences, the hinges need to be ground or other remedial measures taken, causing extra costs and delays. A new method is needed to more accurately predict short-term and long-term hinge deformation to improve safety and reduce costs.

WHAT WAS OUR GOAL?

The goal was to evaluate the Caltrans method (MTD 11-34) to identify the sources of discrepancies between the estimated and actual hinge curls and propose a more accurate method.

Left: Constructing the temporary structure used to support the span (falsework) for the Del Paso Park overhead in Sacramento

Above: Constructing the in-span hinge for the Del Paso Park overhead

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Eliminating Hinge Curl in Bridge Joints During and After Construction

WHAT DID WE DO?

Caltrans, in partnership with the University of Nevada, Reno Center for Civil Engineering Earthquake Research, selected five representative cast-in-place, prestressed concrete box girder bridges across California to monitor time-dependent deflections of in-span hinges. Bridge location, configuration, type, and construction schedule were considered in the selection process. The researchers measured the bridge deformation in the field during construction and compared it to the estimated hinge curl based on the MTD 11-34 design guidelines. They then applied two computer modeling approaches—the SAP2000 program to create a simple stick model, and ABAQUS to capture more-detailed three-dimensional modeling—taking the construction sequence and material time-dependent effects into account. The researchers also conducted parametric studies to investigate the effect of skew angle and superstructure curvature on hinge curl.

WHAT WAS THE OUTCOME?

The field data revealed that the current design method underestimated the deflection of in-span hinges. The primary source of the difference between the estimated and measured hinge curl is the assumption of the boundary condition of the short cantilever. Time-dependent factors also contributed to the discrepancies. Although exact prediction of in-span hinge curl is not possible due to uncertainties in the material properties of the concrete, prestress losses, falsework configuration and settlement, and other factors, using proper boundary conditions and incorporating other adjustments proposed in this study leads to reasonably accurate hinge curl estimates. The research developed a new method and other proposed modifications, along with a design example, in MTD format to facilitate adoption.

In-span hinge of a cast-in-place, prestressed box girder bridge on the N170-N5 connector in Los Angeles

WHAT IS THE BENEFIT?

The detailed field and analytical studies produced a new method that improves the accuracy of hinge curl estimation, thereby reducing the need for corrective measures in the field. Accurate prediction of hinge curl avoids extra construction costs and delays due to hinge curl repair, minimizes post-construction maintenance work, and leads to a safer and smoother ride for the traveling public.

LEARN MORE

To view the complete report:
wolfweb.unr.edu/homepage/saiidi/caltrans/HingeCurl/PDFs/CCEER%2015-03_7-10-15.pdf

Hinge curl remedial measures

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Research Results

Improving Snow and Ice Removal with Modern Equipment

Epoke salt and sand spreaders make snowfighting operations safer and less costly while addressing environmental concerns

Maintenance

DECEMBER 2016

Project Title:
Improved Deicing Methods for Snow and Ice Removal: Epoke Evaluation

Task Number: 2335

Start Date: April 1, 2012

Completion Date: September 30, 2015

Product Category: Evaluation of new commercial products to determine whether they meet Caltrans needs

Task Manager:
Larry Baumeister
Transportation Engineer, Electrical
larry.baumeister@dot.ca.gov

WHAT WAS THE NEED?

Every winter, snowfighting crews in California's mountainous regions must keep the roadways open and safe to accommodate a large volume of passenger and commercial traffic on roads that have steep grades, tight radius curves, and a wide variety of snow conditions. Snow removal and deicing are resource-intensive operations that depend on salt and abrasives that are costly and can also be harmful to the environment. The Caltrans deicing fleet lacks sensors, microcomputers, and other new technologies, so operators cannot control the amount and spread of sand and chemicals. New, commercially available snowfighting equipment supports more precise applications, conserving material, lowering costs, reducing time, increasing safety, and minimizing environmental damage.

WHAT WAS OUR GOAL?

The goal was to evaluate Epoke sander and spreader units for their ability to improve the efficiency, effectiveness, and environmental impact of snow removal and deicing operations.

Caltrans plow trucks with Epokes installed

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Improving Snow and Ice Removal with Modern Equipment

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Davis Advanced Highway Maintenance and Construction Technology Research Center, evaluated the Epoke Sirius Combi 4900 spreader as a potential replacement for its standard V-box sander and spreader. The researchers first compared the spreaders side-by-side on a test track and then deployed two Epoke units along the Interstate 80 corridor at Donner Summit for two winter seasons. The Epoke has an integrated dry material and brine system, with a 5.2 cubic yard hopper for solid material and a 950 gallon tank for liquid brine. The advertised features include an easily adjustable spread pattern and the ability to distribute dry or pre-wetted material across up to three lanes and anti-icing brine across up to two lanes. The researchers equipped each unit with a data collection system to monitor application rate and precision and test the equipment's efficiency for sustainable snow maintenance operations.

WHAT WAS THE OUTCOME?

The evaluation found that the Epoke provided consistent coverage and application rates, leading to significant savings in material usage. The integrated pre-wetting function improves deicing material effectiveness and adhesion. The more precise spreading is also expected to improve traction, increasing traveler safety, and support sustainable snowfighting.

Stripes of liquid behind a low-tech brining truck

WHAT IS THE BENEFIT?

Winter storms affect residents, seasonal visitors, and truckers transporting freight over mountain passes. Poor conditions cause delays, lost revenue from business, collisions, injuries, and fatalities. Modernizing the Caltrans winter fleet improves safety and mobility, applies materials more efficiently, and helps safeguard the environment by reducing the amount of salt and abrasives on the roadways.

LEARN MORE

To view the complete report:
ahmct.ucdavis.edu/pdf/UCD-ARR-15-09-30-06.pdf

Profile of the Kingvale plow truck with V-box (above) and Epoke (below) spreaders installed

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Research Results

Using GPS Guidance for Opening Snowbound Passes

A portable mountain pass road opening system helps operators safely and efficiently clear passes

Maintenance

JANUARY 2017

Project Title:
Evaluation of GPS-based Mountain Pass Opening for Tioga Pass

Task Number: 2337

Start Date: December 15, 2011

Completion Date: September 30, 2015

Product Category: New or improved tool or equipment

Task Manager:
Larry Baumeister
Transportation Engineer, Electrical
larry.baumeister@dot.ca.gov

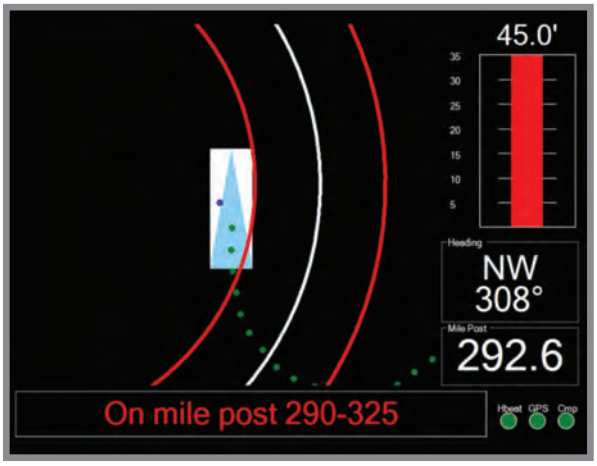
WHAT WAS THE NEED?

California has eight highway mountain passes that are closed during the snow season. Reopening the passes is a difficult and dangerous job because roads can be buried under 25–30 feet of snow, with few visual indicators or landmarks to guide equipment operators. Existing techniques for finding the roads include probing the snow pack with poles, path staking, and active embedded cable systems, which all have associated drawbacks.

A few years ago, Caltrans sponsored the development of a portable, easy to install, and shareable mountain pass road opening (MPRO) system, which was successfully tested for five seasons on Sonora Pass on State Route (SR) 108. The MPRO system uses an infrastructure-free approach that integrates GPS to provide real-time rotary plow driver assistance. To extend the use of the MPRO system to other mountain passes, this project tested its portability by implementing it on Tioga Pass on SR 120, which involved, in addition to moving the physical hardware installation, developing a base map of the area to support the GPS-based location of the vehicle.

WHAT WAS OUR GOAL?

The goal was to implement the Mountain Pass Road Opening system for Tioga Pass to evaluate its portability, adaptability, and performance in a new environment.



The computer display of the MPRO system guides the operator by providing a map of the roadway, mile post, and vehicle direction and height above the roadway.

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Using GPS Guidance for Opening Snowbound Passes

WHAT DID WE DO?

The University of California, Davis Advanced Highway Maintenance and Construction Technology Research Center, which developed the initial MPRO system under a previous research project, adapted the system by creating a high-accuracy Geographic Information System (GIS) map of the Tioga Pass, including buildings, road signs, and guardrails, based on information easily gathered with a mobile terrestrial laser scanner mounted on a vehicle. The researchers incorporated the map with the software, which is displayed on an in-vehicle computer to guide the operator. The system also relies on a GPS receiver, along with a satellite subscription, to provide digital corrections and improve positioning. A watchdog feature provides status indicators for all the sensing systems.

MPRO computer and display

WHAT WAS THE OUTCOME?

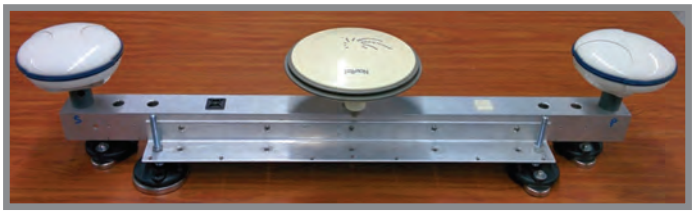
The testing on Tioga Pass was successful, demonstrating the portability of the MPRO system. The mobile terrestrial laser scanning technology enabled the researchers to rapidly generate a detailed base map, an approach that is widely applicable for other uses requiring maps developed in a safe and efficient manner. The MPRO provided an accurate mapping of most of the roadway. In two small areas, the GPS signal could not gather valid data. In these situations, the watchdog feature notified the operator that the MPRO could not be relied on.

WHAT IS THE BENEFIT?

Each spring, equipment operators clear the state's mountain passes to open the roads to support mobility and tourism. Without leaving the vehicle, the MPRO system allows maintenance crews to safely and efficiently find the road that is buried under deep snow and avoid damaging unseen guardrails, signage, and roadside structures. The equipment is portable and easily installed, so a few units can be shared across statewide mountain pass opening operations.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2015/CA16-2337_FinalReport.pdf



GPS receiver and dual GPS Vector unit

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Research Results

All Weather in One Place All the Time

Integration of Aviation Automated Weather Observation Systems (AWOS) with Roadside Weather Information Systems (RWIS) – Prepare System for Deployment – Phase 2

Modal

JANUARY 2017

Project Title:
Integration of AWOS with RWIS – Prepare System for Deployment

Task Number: 1768

Start Date: April 20, 2011

Completion Date: December 31, 2015

Product Category: New or improved decision support tool, simulation, model, or algorithm

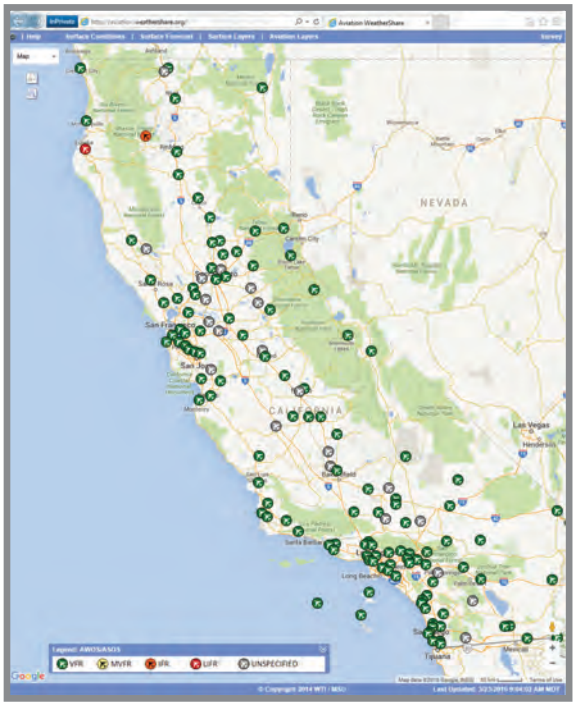
Task Manager:
Melissa Clark
Transportation Engineer, Electrical
melissa.clark@dot.ca.gov

WHAT WAS THE NEED?

Current system managers and users (airport managers, flight managers and service centers, pilots, etc.) use multiple systems to obtain various aviation related data for trip planning purposes. These systems include, but are not limited to: AWOS (Automated Weather Observing Systems), ASOS (Automated Surface Observing Systems), and RWIS (Roadside Weather Information Systems). Each system provides similar meteorological information to support safe and efficient transportation across multiple modes, but they are operated independently of each other. Each system is maintained by other resources and publicly available. Individuals would need to access each system's information, by different public data feed (website, phone lines, etc.), to capture the unique data from that system. There was no centralized system from which they can obtain these multiple data feeds.

WHAT WAS OUR GOAL?

The goal was to capitalize on new technology that enables the importing of data from public weather providers to be viewed from one website. This approach offers multiple weather reporting types from existing, credible, weather agencies on a single website giving a broader picture of weather that could affect aviation in areas that otherwise would not have this capability.



The website displays aviation weather conditions and forecasts from numerous sources for the entire state.

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All Weather in One Place All the Time

WHAT DID WE DO?

Western Transportation Institute (WTI) researchers launched a web-based tool for California's airports and heliports, particularly targeting small, under-served rural airfields and hospital heliports used for emergency services. During this phase, they:

- Developed a business case to help Caltrans to determine whether and how to proceed with full deployment.
- Enhanced the system to expand the coverage area; improve usability, effectiveness, reliability and scalability; and add further useful functionality.
- Promoted system usage and awareness through on-going outreach, training and support.
- Evaluated the prototype system over multiple seasons and with a wider audience of prospective users.

The prototype system provides localized, timely weather conditions and forecast information from numerous sources, including:

- Surface weather data from Meteorological Assimilation Data Ingest System, MesoWest, and Caltrans
- National Digital forecasts from the National Weather Service (NWS)
- AWOS data
- NWS watches, warnings, advisories, winds, and temperatures aloft forecasts
- Closed-circuit television images from Caltrans Roadside Weather Information Systems
- Pilot reports from the NWS Aviation Weather Center
- NWS terminal aerodrome forecasts
- Wind and temperature aloft forecast data from National Centers of Environmental Prediction
- NWS satellite images

WHAT WAS THE OUTCOME?

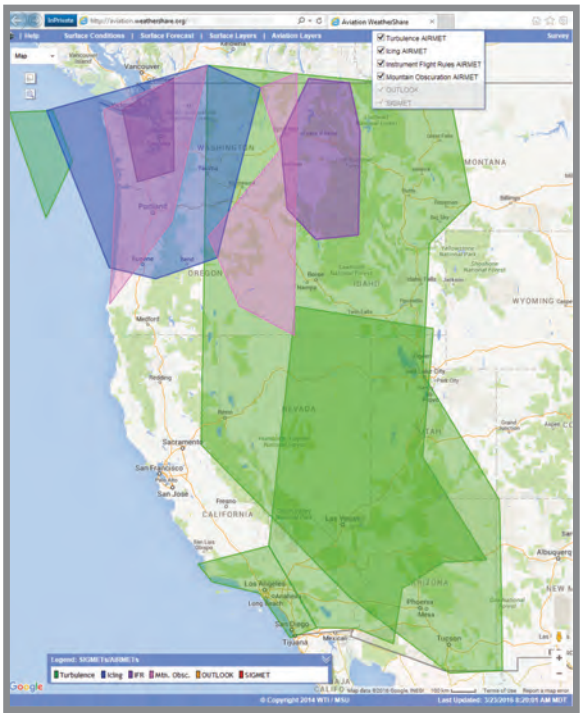
Before the development of the prototype system, users needed to access disparate, independently operated systems to obtain wind and temperature conditions, forecasts, warnings, and advisories, which was time consuming and demanded different means of access. Centralizing the information enables users to obtain multiple data feeds in one place, providing a comprehensive picture of the conditions affecting air travel to make a more informed and efficient assessment. The project is now complete and the system will be migrated from WTI to a server to be maintained and supported by Caltrans. The name of the new system will be Aviation Weather Information Web Portal. The transfer is expected to begin in Spring 2017.

WHAT IS THE BENEFIT?

The system will improve safety and increase efficiency in Caltrans as well as other aviation agencies. The system will help aviators to make more informed decisions; enable more system/airport managers to access meteorological conditions data in order to enhance operational safety, reliability and efficiency; and it will enable residents and travelers to access weather information in larger areas. The unified data source will provide for better aviation-related trip planning.

LEARN MORE

aviationdemo.weathershare.org



Users can get a quick status of turbulence, icing, and other conditions that affect aviation conditions.

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Research Results

Improving Cargo Flow at Ports with Dynamic Truck Management

Mobile app tracks truck locations in real time helping to sort containers for pick up more efficiently and shortening turnaround time at ports

Modal

FEBRUARY 2017

Project Title:
Smart Truck Driver Assistant: A Cost Effective Solution for Real Time Management of Container Delivery to Trucks

Task Number: 2820

Start Date: January 1, 2015

Completion Date: December 31, 2015

Product Category: New or improved decision support tool, simulation, model, or algorithm

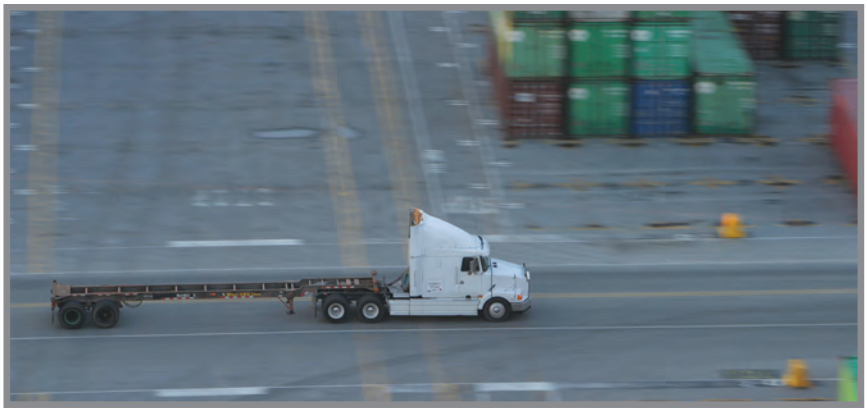
Task Manager:
Matt Hanson
Transportation Engineer
matt.hanson@dot.ca.gov

WHAT IS THE NEED?

The adjacent Los Angeles and Long Beach container ports are two of the busiest in the country, serving as a major gateway for the nation and state's exports and imports. The ports' productivity and performance are highly dependent on how quickly the container trucks can enter the port and depart. Trucks are often forced to idle outside the gate waiting to be served, increasing traffic congestion and air pollution. Because of the uncertainty of truck arrivals, containers are randomly stacked on each other in rows in the terminal yard and then need to be moved around when a particular container is ready for loading. Shuffling through the containers decreases terminal and trucking productivity and increases labor costs and risk of accidents. To increase efficiency, terminals have tried scheduling truck arrivals, but an appointment system has been ineffective in reducing queuing due to the unpredictability of traffic in the Los Angeles metropolitan area. A solution that promotes dynamic scheduling decisions based on real-time data can improve trucking and port operations by supporting more efficient container management and shortening truck turnaround time.

WHAT IS OUR GOAL?

The goal was to improve the efficiency of the container storage and retrieval system at ports by tracking a truck's location in real time to reduce queuing and terminal visit times.



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WHAT DID WE DO?

Caltrans, in partnership with the METRANS Transportation Center, developed a mobile application that uses a smartphone's sensors and GPS to precisely track truck movement in real time outside and inside port terminals. Because most truckers now carry smartphones, the solution, designed by researchers at California State University, Long Beach, eliminates the cost of additional equipment. The mobile app provides drivers with wait-time information to improve their efficiency, and terminal operators can foresee the traffic patterns and identify specific container needs. The app also collects data as input for detailed models of cargo traffic flow in and around terminals to help optimize truck and container routing and identify higher accident areas to improve port safety.

WHAT IS THE OUTCOME?

The developers have successfully tested the first-generation mobile app at mock terminals, and it is fully functional. The next step is to conduct field tests. The app can also be extended to further optimize container movement to reduce truck turnaround time and potentially increase terminal and port performance.

App registration and trip view

WHAT IS THE BENEFIT?

The mobile app addresses the bottleneck of getting containers to and from port terminals by tracking truck movement in real time without purchasing additional equipment. Truck drivers can receive information about shipments and optimal arrival times to minimize queuing and waiting for containers to be located. The longer a truck waits, the more it reduces a company's shipping capacity and contributes to congestion and air pollution. To remain competitive, ports must perform as efficiently as possible. Knowing when trucks will arrive enables terminal operators to sort containers accordingly, reducing reshuffling and truck wait times. Optimizing container storage and handling reduces labor costs and the risk of accidents. Trucking companies can also use the tool to obtain precise real-time information about conditions at the ports, allowing them to optimize their operations.

LEARN MORE

To view the complete report:
www.metrans.org/sites/default/files/research-project/Englert%20Final%20Report%2014-13.pdf

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Research Results

Ridesharing as a Transit System Feeder

Ridesharing services can address public transportation's first-last mile problem and increase transit ridership

Modal

FEBRUARY 2017

Project Title:
Promoting Peer-to-Peer Ridesharing Services as Transit System Feeders

Task Number: 2806

Start Date: March 1, 2015

Completion Date: May 1, 2016

Product Category: New or improved decision support tool, simulation, model, or algorithm

Task Manager:
David Chursenoff
Associate Transportation Planner
david.chursenoff@dot.ca.gov

WHAT WAS THE NEED?

An ongoing challenge for public transit is how to get riders from their front doors to the nearest transit stop and ultimately to their final destination—referred to as the first-mile, last-mile problem. Most people in the United States are comfortable walking about one-quarter of a mile to and from a transit stop. Yet most locations in an urban area are beyond an easy walking distance to transit, discouraging travelers from replacing their cars with public transportation. Beyond constructing park-and-ride facilities, which is not always an option in urban areas, transit agencies have considered and tested various ways to address the first-last mile, such as providing secure bike storage or onboarding, bikesharing, and carsharing. But for many potential transit riders, their trip origin and destination fall too far out of range from a transit station for convenient access via walking or bicycling.

With smartphones becoming more ubiquitous, ridesharing services are an emerging travel option that can help accommodate the growth in urban travel demand and alleviate vehicular emissions. Prior ridesharing research has suggested that the demand for ridesharing diverts people from using public transit and that ridesharing's true social and environmental benefits are obtained only if demand is shifted from private auto travel. However, ridesharing services could possibly encourage more ridership by providing convenient options for people to get from point to point while requiring no change in scheduling or infrastructure for the transit agency.

WHAT WAS OUR GOAL?

The goal was to develop a mobile application that provides real-time ride matching and key transfer points to augment demand for public transit and reduce private auto use.

App showing matched results for ridesharing options at transit stops

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WHAT DID WE DO?

Caltrans, in partnership with the University of California Center on Economic Competitiveness in Transportation (UCCONNECT), examined the potential of promoting ridesharing as a demand generator for transit by incorporating real-time transit station transfers into the travel routes suggested by the algorithms used in ridesharing services. The UC Irvine researchers used the Los Angeles Metro Red Line as a case study because it had recently shown declining ridership. The mobile app's innovative ride-matching algorithm suggests routes that combine ridesharing and transit. The researchers conducted a simulation to evaluate metrics such as transit demand augmentation potential, station efficiency, and pricing sensitivity. For successful ridesharing, strategically selecting transit stations to minimize wait time is crucial, along with the pricing structure for rides, which can be adjusted dynamically based on feedback from app users.

WHAT WAS THE OUTCOME?

There is a range of distance-based ridesharing fares for which people will choose ridesharing over solo driving. Ridesharing trips whose origins and destinations fall within close proximity to the LA Metro Red Line complemented the use of public transit. The mobile application developed will be field-tested in a later study to further assess its functionality.

Los Angeles Metro Red Line

WHAT IS THE BENEFIT?

Ridesharing has the potential of augmenting transit demand by solving the first-last mile problem. By coordinating public transit routes and real-time schedules, wait time between connections is minimized, making transit more efficient and attractive. With higher transit ridership stemming from improved access, urban congestion and excessive vehicular emissions can potentially be reduced.

LEARN MORE

To view the complete report:
http://www.dot.ca.gov/research/researchreports/reports/2016/CA16-2806_FinalReport.pdf

DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

These Feet Were Made for Walking

Identifying the factors that influence the decision to walk supports incorporating pedestrian needs in regional travel demand models

Modal

FEBRUARY 2017

Project Title:
Heightening Walking Above Its Pedestrian Status: Walking and Travel Behavior in California

Task Number: 2802

Start Date: April 23, 2015

Completion Date: June 30, 2016

Product Category: New or improved decision support tool, simulation, model, or algorithm

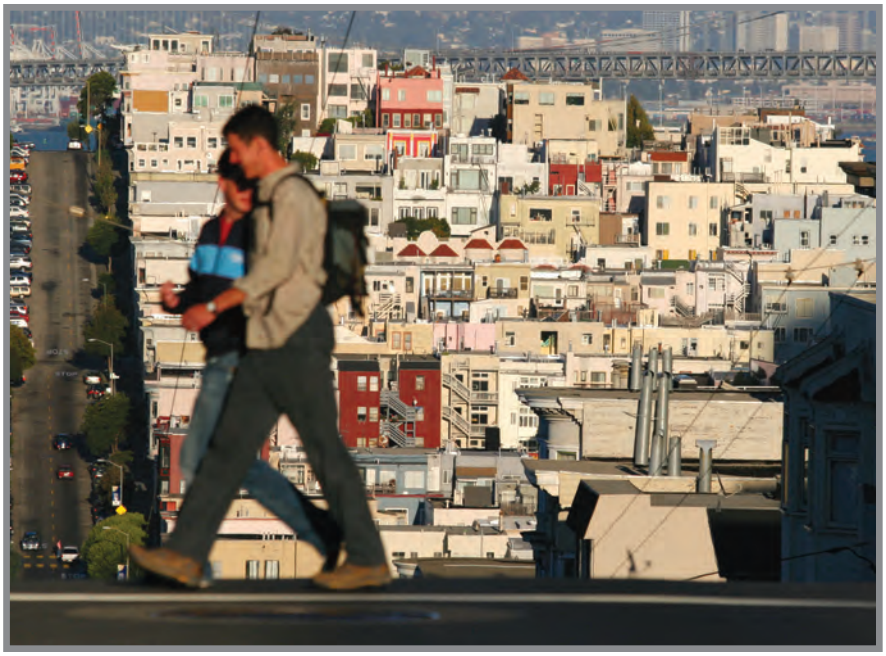
Task Manager:
Gloria Gwynne
Senior Engineer
gloria.gwynne@dot.ca.gov

WHAT WAS THE NEED?

Walking is the second-most common travel mode in California—walk trips begin and end almost every journey, even trips made by automobile. Traveling by foot produces no greenhouse gas emissions, adds no congestion, promotes social interaction and local shopping, and is good for individual and public health. Yet despite its prevalence and benefits, walking is an understudied travel mode, and travel surveys tend to underreport walk trips. As a result, pedestrian considerations are not adequately incorporated into regional planning.

WHAT WAS OUR GOAL?

The goal was to improve the understanding of the determinants of walking and to better incorporate it into regional travel demand models.



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WHAT DID WE DO?

Caltrans, in partnership with the University of California Center on Economic Competitiveness in Transportation (UCCONNECT), reviewed the data from the last two California Household Travel Surveys, 2001 and 2012, to analyze walking behavior and how it has changed over time in four major California regions—the San Francisco Bay Area, Los Angeles, Sacramento, and San Diego, comprising over 60% of the state's population. The UCLA researchers examined the relationship between walking, the built environment, economics, and neighborhood characteristics and how these factors differ in the four metropolitan regions. The study paired the statistical analysis with interviews with Metropolitan Planning Organization (MPO) representatives to understand whether and how walking trips are included in regional travel demand models.

WHAT WAS THE OUTCOME?

While walking remains a relatively small share (9%) of trips within the study areas, it is nine times more than the percentage of trips taken by public transit or bicycle, and walking rates have almost doubled since 2001. Walking is a simple way to get around, but modeling this simple mode is complicated, although the major California MPOs are doing a better job than many other parts of the country. The interviews showed that most MPOs have shifted to activity-based models, which are better suited to understanding walking compared to the traditional models that focus on trip generation. The decision to walk is influenced by various factors, including characteristics of the person, household, trip type, and built environment and the region in which the trip occurs. The built environment has a positive but small effect on walking, however the data also shows that neighborhoods are slowly changing in ways that encourage walking, such as increased housing and employment densities. Additionally, there is a strong relationship between walking and trip distance, which is influenced by the built environment, particularly the quantity and quality of local destinations.

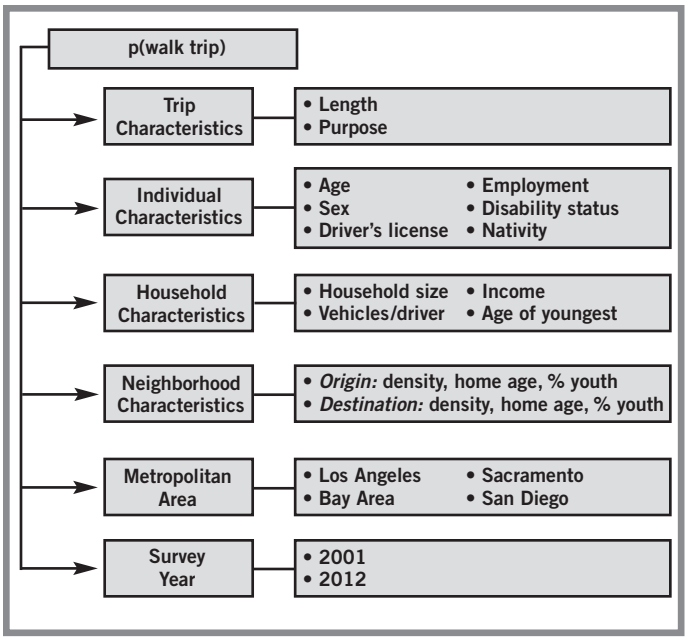
The most success might be garnered by targeting changes in the built environment of population groups that already exhibit relatively high rates of walking, such as addressing safety and crime issues in low-income and immigrant neighborhoods where a disproportionate number of households do not own automobiles, improving the proximity of family and child-oriented amenities, and adopting planning efforts to provide access (within a half mile) to everyday destinations.

WHAT IS THE BENEFIT?

A growing body of research shows relationships between neighborhoods that are pedestrian-friendly and lower obesity rates, higher property values, improved quality of life, and better access to opportunities. The research provides the basis for recommendations to encourage walking and to better incorporate it in data collection efforts and regional travel demand models. Regional travel demand models are often the basis for allocating funds for future transportation investments. Expanding and improving the way travel data is collected broadens the understanding of walking behavior and the factors that influence it.

LEARN MORE

To view the complete report:
www.its.ucla.edu/wp-content/uploads/sites/6/2016/08/Blumenberg_HeighteningWalking_FINAL-2.pdf



Conceptual model of determinants of walking

DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Blending Virgin Binders with Higher Percentages of Reclaimed Materials

Fine aggregate matrix testing is a quicker method to test the performance of mixes with higher percentages of reclaimed asphalt pavement and recycled asphalt shingles

Pavement

JANUARY 2017

Project Title:
Evaluation of the Combined Effect of Recycled Asphalt Pavement (RAP), Recycled Asphalt Shingles (RAS), and Different Virgin Binder Sources on Performance of the Blended Binder for Mixes with Higher Percentages of RAP and RAS

Task Number: 2827

Start Date: November 20, 2014

Completion Date: September 30, 2015

Product Category: New or improved technical standard, plan, or specification

Task Manager:
Hamid Sadraie
Research Engineer
hamid.sadraie@dot.ca.gov

WHAT WAS THE NEED?

Maintenance and rehabilitation of the state's roadways requires a continuous supply of aggregate and asphalt binders, both of which are becoming increasingly scarce and more expensive. To reduce costs and preserve nonrenewable resources, Caltrans promotes using higher percentages of reclaimed materials, such as reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS) in the production of new asphalt mixes. However, it is unknown how blending the aged, stiffer RAP and RAS binders with the asphalt mix's virgin binder affects the pavement's performance and durability over time. To avoid premature failures resulting from ineffective blending or accelerated aging requires testing. Current practice uses aggressive chemical processes to extract and recover the binder from RAP and RAS to test their effect on the asphalt mix. These processes can alter the properties of the aged binders. As a result, a new method to test the effects of RAP and RAS on new asphalt mixes needed to be developed.

WHAT WAS OUR GOAL?

The goal was to investigate substituting higher percentages of RAP and RAS for the virgin binder in new asphalt mixes and to develop a method that does not use chemical extraction and recovery processes to test how the reclaimed materials affect performance.

Coring of a fine aggregate matrix cylinder from a Superpave gyratory compacted specimen

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Blending Virgin Binders with Higher Percentages of Reclaimed Materials

Research Results

WHAT DID WE DO?

Caltrans partnered with the University of California Pavement Research Center at Davis to test the fine aggregate matrix (FAM) of mixes containing higher percentages of RAP as an alternative to extracting binder from the RAP and then blending it with the virgin binder. The evaluation included two performance grades of five asphalt binders sourced from three California refineries. The researchers reviewed the influence of 25% and 40% RAP replacement and compared the FAM test results with binder tests that used extraction and recovery processes. The project also examined the effects of the virgin binder source, virgin binder grade, RAP and RAS source, RAP and RAS content on the asphalt mixes, and using a petroleum-based rejuvenating agent in selected mixes.

WHAT WAS THE OUTCOME?

Fine aggregate matrix testing is a potential procedure for evaluating the properties of blended asphalt binder in mixes containing high percentages of RAP and RAS. As expected, the statistical analyses of the test results indicated that the stiffness of the FAM is influenced by the RAP and RAS content, asphalt binder grade and source, and rejuvenating agent. The effect of RAP in increasing the stiffness of blended binders depends on the asphalt binder grade and, to a lesser extent, the source of the asphalt binder. The researchers could not test asphalt binder extracted and recovered from RAS due to its high stiffness. The influence of the rejuvenating agent on reducing the blended binder and FAM mix stiffnesses was evident.

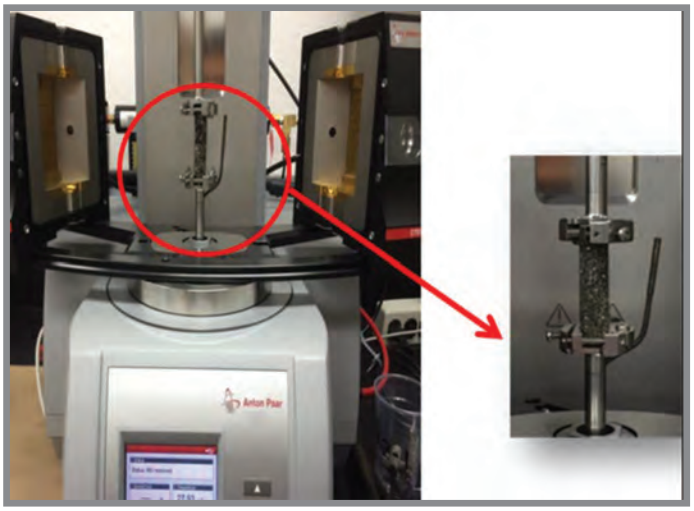
Weight station for air-void measurement (left) and FAM specimen storage (right)

WHAT IS THE BENEFIT?

Using reclaimed asphalt reduces demand on nonrenewable virgin materials, but it is necessary to ensure that the aged RAP and RAS binders do not adversely affect performance and durability. The new FAM testing is an effective alternative to chemical extraction and recovery for evaluating asphalt mixes with higher percentages of RAP and RAS content.

LEARN MORE

To view the complete report:
www.ucprc.ucdavis.edu/PDF/UCPRC-RR-2015-06.pdf



FAM testing setup: a dynamic shear rheometer with a torsion bar fixture

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Research Results

Improving the Foundation Layers for Concrete Pavements

Research leads to making pavement foundations more durable, uniform, constructible, and economical

Pavement

JANUARY 2017

Project Title:
Improving the Foundation Layers for Concrete Pavements, TPF-5(183)

Task Number: 2020

Start Date: June 19, 2008

Completion Date: June 30, 2016

Product Category: New or improved technical standard, plan, or specification

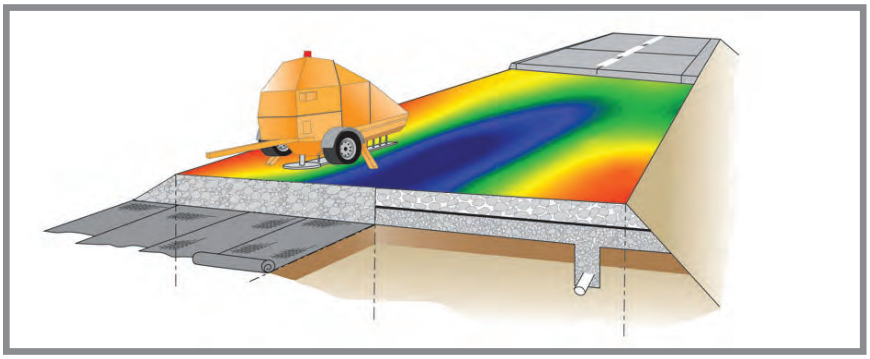
Task Manager:
Yue Wang
Transportation Engineer
yue.wang@dot.ca.gov

WHAT WAS THE NEED?

The pavement foundation layer plays a critical role in achieving good pavement performance and durability. A high number of pavement failures are due to an inadequate subbase, natural subgrade, and embankment, commonly referred to as the foundation layer or roadbed. In recent years, especially with increasing truck traffic, the quality of the pavement foundation layer has become even more critical in its ability to bear the heavy loads. Multiple factors contribute to pavement foundation problems, including poor construction practices, inadequate quality control testing methods and sampling plans, material variability and unpredictable long-term behavior, poor verification of material properties during construction, insufficient development of performance-related specifications, and low capital investment. To make pavement foundations more durable, uniform, constructible, and economical, five states, California, Iowa, Michigan, Pennsylvania, and Wisconsin, worked in conjunction with the Federal Highway Administration to research ways to improve design and construction methods.

WHAT WAS OUR GOAL?

The goal was to develop better design and construction practices to improve the quality of pavement foundation layers.



Pavement foundation study reveals non-uniform support conditions

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WHAT DID WE DO?

Led by the Iowa Department of Transportation (DOT), Caltrans and the other state DOTs investigated all aspects of foundation layers, including thickness, material properties, permeability, stiffness, strength, volumetric stability, and durability. The researchers conducted comprehensive field studies in each participating state on existing pavement sections that had good and poor performance as well as examined new roadbed projects. The evaluations used both current practices and emerging technologies, such as intelligent compaction, to measure performance-related parameters as opposed to just index-related or indirectly related parameter values.

WHAT WAS THE OUTCOME?

Evaluating the pavement foundation design input parameters at each site provided a link between what was assumed during design and what was actually constructed. The research addressed the range of inputs related to foundation layers to provide improved guidelines for all parameters by maximizing the various possible field conditions, including different soil and climatic attributes. The field testing recommendations, design aids, and suggested specifications will be included in the *Manual of Professional Practice for Design, Construction, Testing and Evaluation for Concrete Pavement Foundations*, which is compatible with California's pavement design methodology and the *Mechanistic-Empirical Pavement Design Guide*. The research findings are applicable to foundations for portland cement concrete and asphalt concrete pavement.

Evaluating the physical properties of concrete pavement over a polyurethane foam-stabilized base using a falling weight deflectometer device

WHAT IS THE BENEFIT?

Ongoing maintenance and rehabilitation of pavement foundations is costly and contributes to congestion due to poor driving conditions or road closures during repairs. The manual and guidelines developed during this project helps Caltrans improve pavement foundation design, construction, testing, and evaluation practices.

LEARN MORE

For more information:
www.ceer.iastate.edu/research/project/project.cfm?projectID=-1425669311

Field testing on a dense grid to capture the spatial variability of foundation layer support conditions

Field testing an injected, high-density polyurethane foam-stabilized base under concrete pavements

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Research Results

Reducing GHG with New Transportation Technologies and Policies

Do dynamic ridesharing and electric vehicles have synergistic interactions with land use, transit, and auto-pricing policies?

Planning/ Policy/ Programming

FEBRUARY 2017

Project Title:
Synergistic Integration of Transportation Demand Management Strategies (Land Use, Transit, and Auto Pricing) with New Technologies and Services (Battery Electric Vehicles and Dynamic Ridesharing) to Enhance Reductions in VMT and GHG

Task Number: 2636

Start Date: July 7, 2014

Completion Date: July 31, 2015

Product Category: New or improved policy, rule, or regulation

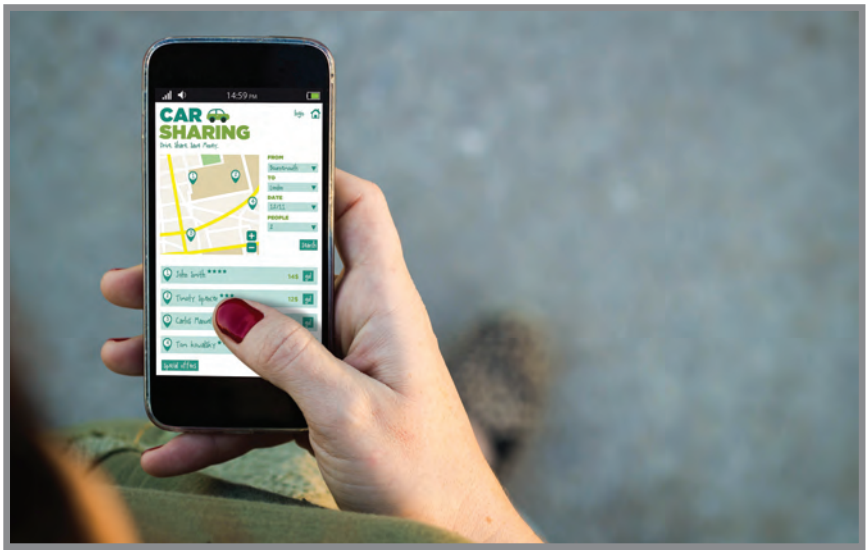
Task Manager:
Patrick Tyner
Associate Transportation Planner
patrick.tyner@dot.ca.gov

WHAT WAS THE NEED?

Meeting California's greenhouse gas (GHG) reduction goals requires more than just new vehicle and fuel technologies. Other strategies to get people out of their cars and reduce the vehicle miles traveled (VMT) are needed, such as transit-oriented developed, expanded biking and walking access, and auto-pricing policies that encourage the purchase of battery electric vehicles (BEV) as well as discourage solo driving. Transportation services, such as ridesharing and carsharing, present new options that can influence land use and transit policy decisions to improve mobility and the environment.

WHAT WAS OUR GOAL?

The goal was to explore how demand management strategies can be combined with new vehicle technologies and ridesharing services to reduce vehicle miles traveled and greenhouse gas emissions.



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Reducing GHG with New Transportation Technologies and Policies

Research Results

WHAT DID WE DO?

Caltrans, in partnership with the Mineta Transportation Institute, used the San Francisco Bay Area Metropolitan Transportation Commission's 2010 activity-based travel demand model to examine potential markets for dynamic ridesharing and BEVs by simulating business-as-usual, transit-oriented development, and auto-pricing scenarios with and without high, medium, and low dynamic ridesharing participation rates and BEV daily driving distance ranges. Unlike traditional trip-based travel demand models, which focus primarily on getting from one point to another, activity-based models are based on the principle that travel demand is derived from individuals' daily activity patterns—when, where, for how long, and for and with whom the travel choices are made. The UC Davis researchers used the resulting data to identify the number of individuals, their characteristics, and which trips could feasibly use new technology and services and the potential magnitude of avoided vehicle trips on VMT and GHG emissions. For instance, purchasing a BEV, which has a driving range of 60–125 miles, or using a dynamic ridesharing service is more likely when distances to destinations are shorter and alternative modes of travel are provided.

WHAT WAS THE OUTCOME?

Dynamic ridesharing has the potential to reduce VMT and related GHG emissions if travelers are willing to pay with both time and money to use the ridesharing system. However, in general, the research did not find synergistic effects between ridesharing and transit-oriented development or auto-pricing policies. The results of the BEV simulations suggest that transit-oriented development could increase the use of BEVs by less than 1% in the Bay Area and auto-pricing policies by as much as 7%, although greater changes are possible in faster growing regions, such as the Central Valley, where development is currently at low density levels. VMT fee and auto-pricing scenarios show the greatest potential to increase the BEV market.

WHAT IS THE BENEFIT?

Reduced car ownership tends to decrease car travel and encourage transit, walking, and biking. Policies such as transit-oriented development can reduce the spatial distribution of trip origins and destinations and thus increase ridesharing. In addition, expanding transit, walking, and bike access increases the probability of ridesharing for one or more segments to complete the trip. Auto-pricing policies, such as VMT fees, increase the incentive to form rideshares to reduce travel costs. Higher costs of auto travel could encourage shorter distances between residential and employment locations and more development around transit, and thus further increase the feasibility of ridesharing. The emerging modeling tools help planners better gauge markets for new services and evaluate and advocate for methods to achieve deeper GHG reductions based on land use and transportation scenarios.

LEARN MORE

To view the complete report:
transweb.sjsu.edu/project/1207.html

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Research Results

The Mobility of Millennials in California

New data provides transportation professionals a better understanding of young adults' travel behavior, lifestyles, personal attitudes, and propensity to purchase a vehicle

Planning/ Policy/ Programming

MARCH 2017

Project Title:
What Affects Millennials' Mobility? Investigating the Environmental Concerns, Lifestyles, Mobility-Related Attitudes and Adoption of Technology of Young Adults in California

Task Number: 2829

Start Date: October 1, 2014

Completion Date: September 30, 2015

Product Category: Processed data/ database

Task Manager:
David Chursenoff
Associate Transportation Planner
david.chursenoff@dot.ca.gov

WHAT WAS THE NEED?

Young adults, between the ages of 18 and 34, often referred to as millennials or Generation Y, are increasingly reported to have different lifestyle and travel behavior from previous generations at the same stage in life. Millennials tend to postpone obtaining a driver's license, choose to live in urban locations, not own a car or drive less if they do, and use alternative travel modes more often. However, the reasons behind these trends and their long-term effects on the future growth of cities are unclear, and most studies and conclusions have been based on speculations that are not supported by robust data or empirical findings. Almost 10 million young adults live in California, representing approximately 25% of the population. This study investigated millennials' mobility-related decisions to understand how their preferences affect car ownership and other transportation planning.

WHAT WAS OUR GOAL?

The goal was to research how young adults' travel behavior will shape California's future transportation demands and affect planning.

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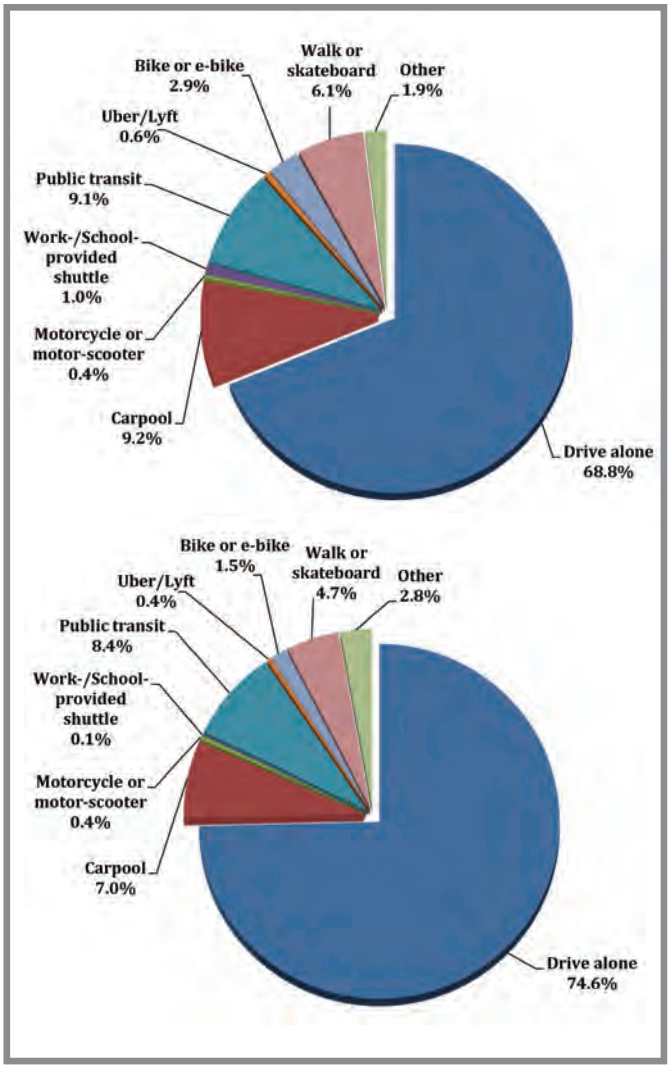
WHAT DID WE DO?

Caltrans, in partnership with the National Center for Sustainable Transportation, conducted an in-depth online survey to collect empirical data on young adults' travel expectations and behavior and the factors affecting their choices, such as the adoption of new technologies, shared mobility services, and alternative-fuel vehicles, environmental concerns, the role of peer influence and social media, cultural, lifestyle, sociodemographic, and residential traits, travel mode choices, and attitudes toward car ownership. The UC Davis researchers distributed the survey to 2,400 respondents: 1,400 millennials between the ages of 18 and 34, and 1,000 members of Generation X (aged 35–50) for comparison purposes.



Commute modes based on survey respondents: Millennials (top); Gen X (bottom)

WHAT WAS THE OUTCOME?

The *California Millennials Dataset* provides unprecedented, detailed information on what shapes and influences young adults' travel behavior. On average, millennials in both urban and suburban areas drive 15% fewer miles by car than members of Generation X. Consistent with expectations, millennials more readily adopt technological solutions and use smartphone apps more than Gen Xers. Millennials also report using their devices more often while they travel to identify possible destinations, such as a restaurant, get directions, and decide which means of transportation or combination to complete a trip. Millennials also show a stronger commitment to protect the environment and are less opposed than members of Gen X to policies that increase gas taxes to provide better funding for public transportation and reduce the environmental impacts of transportation. Although millennials have higher rates of adoption of emerging transportation and shared-mobility services, members of Gen X using on-demand ride services are predominantly replacing the use of private cars, whereas millennials report that ridesharing reduces their use of public transportation, walking, and biking.

WHAT IS THE BENEFIT?

As one-quarter of the state's population, millennials' preferences have an important effect in shaping society. The data collected expands transportation professionals' understanding of millennials' mobility-related decisions and the factors that influence them. The rich dataset supports better transportation planning and decision-making in California.

LEARN MORE

To view the complete report:
ncst.ucdavis.edu/wp-content/uploads/2014/08/05-26-2016 NCST_Report_Millennials_Part_I_2016_May_26_FINAL1.pdf

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Research Results

Balancing Costs and Environmental Impact in Pavement Management

New tool helps determine when to optimally rehabilitate road segments and reduce greenhouse gas emissions

Planning/ Policy/ Programming

JANUARY 2017

Project Title:
Balancing Life-cycle Cost and Life-cycle Impact Considerations in Pavement Management

Task Number: 2645

Start Date: March 1, 2015

Completion Date: January 31, 2016

Product Category: New or improved decision support tool, simulation, model, or algorithm

Task Manager:
Joe Holland
Pavement Research
t.joe.holland@dot.ca.gov

WHAT WAS THE NEED?

The United States has set a target of reducing greenhouse gas (GHG) emissions by 26% to 28% below 2005 levels by 2025. Traditionally, pavement maintenance policies have strived to find the balance between user costs due to pavement roughness and agency costs associated with reducing roughness. To address the environmental impact of pavement maintenance, developing methods that encompass both the optimization of the pavement condition and reduction of GHG emissions is the next step in pavement management. Poor road conditions lead to increased fuel consumption and emissions. Rehabilitation activities improve roughness, but require materials and construction equipment, which also produce GHG emissions. Although studies have demonstrated a range of potentially optimal solutions in terms of the trade-offs between costs and GHG emissions, they have not considered the constraints that many agencies face in terms of reducing the carbon footprint while operating under a limited financial budget.

WHAT WAS OUR GOAL?

The goal was to develop a method to balance the life-cycle costs of optimizing pavement maintenance while reducing GHG emissions.

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Balancing Costs and Environmental Impact in Pavement Management

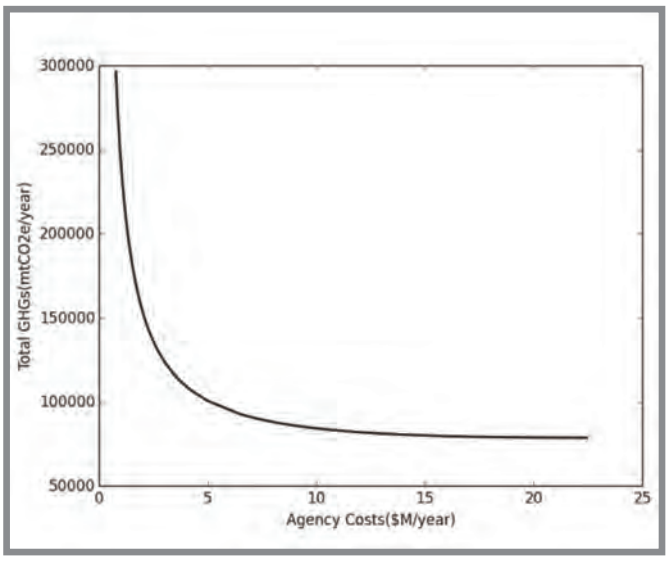
Research Results

WHAT DID WE DO?

The researchers developed a dual-solution methodology that selects the optimal timing and optimal action from a set of alternatives for resurfacing a road segment and examined its applicability by applying it to a case study of California roads. The formulation quantifies GHG emission savings per additional dollar of agency budget spent, which can be used in a cap-and-trade system or to make budget decisions. They used a Pareto curve to visually show the trade-offs and help decision-makers strike the proper balance.

WHAT WAS THE OUTCOME?

Road agencies can use this methodology to balance optimal resurfacing policies and minimize the GHG emissions associated with pavement rehabilitation while operating under a constrained financial budget. The case study found that to minimize costs it is optimal to apply frequent, thin resurfacings to pavement, which is contrary to the less frequent, thick overlays specified in the literature. It is recommended that the research be expanded to also include reconstruction as an alternative so that the methodology is more broadly applicable, as well as incorporate other environmental metrics, such as particulate matter.



Comparing agency costs to total GHG emissions

WHAT IS THE BENEFIT?

Budget influences pavement management policies. California must balance its goals of maintaining pavement condition and minimizing the carbon footprint associated with road rehabilitation policies. The methodology produced can predict how much it will cost to reduce GHG emissions for a particular roadway network by altering pavement maintenance policies. Decision-makers can identify the optimal timing in the presence of fiscal constraints. The methodology can also be used to compare spending money on pavement rehabilitation or another project within its scope, such as roadway lighting, to determine which is a better investment.

LEARN MORE

To view the complete report:
iopscience.iop.org/article/10.1088/1748-9326/ 10/11/114007

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Research Results

Does Traffic Congestion Impede Economic Activity in Metropolitan Areas?

Shifting the focus from mobility to accessibility changes the measure from faster, faster, faster to location, location, location

Planning/ Policy/ Programming

APRIL 2017

Project Title:
Not So Fast: A Study of Traffic Delays, Access, and Economic Activity in the San Francisco Bay Area

Task Number: 2798

Start Date: March 1, 2015

Completion Date: March 31, 2016

Product Category: New or improved policy, rule, or regulation

WHAT WAS THE NEED?

Traffic congestion is often cited as an impediment to metropolitan economies because it wastes commuters' time and inhibits business growth. This premise is used to justify large transportation infrastructure investments and to block urban development, with the goal of improving mobility as opposed to accessibility, which is a function of both proximity and speed. The assumption is that moving slower than free-flow speeds wastes time and fuel and that these time and fuel costs multiplied over millions of travelers in large urban areas add up to billions of dollars in congestion costs. For example, a 10-mile, 10-minute suburb-to-suburb freeway commute to work at 60 miles per hour has no congestion costs, while a 2-mile, 10-minute drive to work on busy city streets—a commute of the same time but shorter distance—costs a commuter more than 13 minutes of wasted time and fuel per round trip. Previous studies have measured how travel speed or proximity affect job access, but combining these two factors across a large region like the San Francisco Bay Area to evaluate what role congestion has in an area's economy and the locational choices of new firms has not been considered.

WHAT WAS OUR GOAL?

The goal was to examine how traffic congestion affects key industries and the overall economic performance of a region.

Adding new development in high-density areas can be an economic driver, despite increased congestion, by increasing accessibility and attracting similar businesses and industries that benefit from close proximity.

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Does Traffic Congestion Impede Economic Activity in Metropolitan Areas?

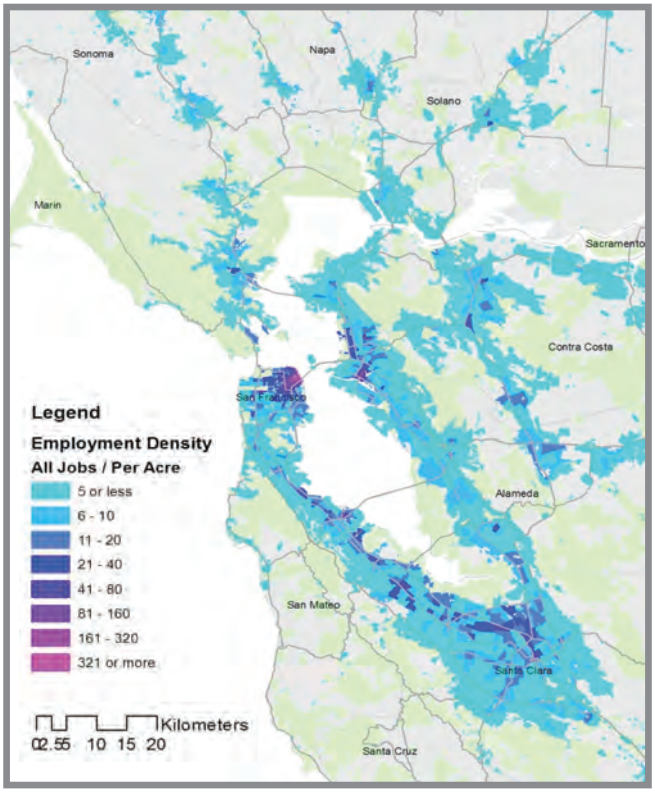
Research Results

WHAT DID WE DO?

Caltrans, in partnership with the University of California Center on Economic Competitiveness in Transportation (UCCONNECT), measured how traffic congestion affects economic performance and new growth in the San Francisco Bay Area, which experiences some of the most severe traffic congestion in the country, by focusing on five industries: advertising, entertainment, IT, securities, and grocery. UCLA researchers drew traffic, travel time, demographic, employment, and economic activity data from the National Establishment Time-Series, the San Francisco Bay Area Metropolitan Transportation Commission, and the U.S. Census Bureau's American Community Survey.

WHAT WAS THE OUTCOME?

The researchers did not find evidence that chronic traffic congestion is driving businesses out to less congested parts of the Bay Area. Rather, access to other business activities and services influences new businesses and employment opportunities more than congestion levels, as also reflected in a comparable study of the Los Angeles region. More jobs can be reached in a given amount of travel time through the congested streets of San Francisco than on fast-moving freeways and boulevards in the fringes of the Bay Area.



Employment density in the San Francisco Bay Area, based on 2009 data

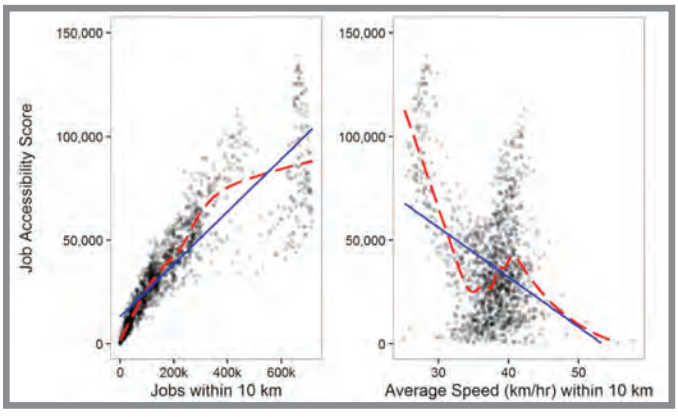
Using level-of-service metrics that rate roadways based on the amount of delay favors high travel speeds rather than access and ignores the tendencies of certain industries to co-locate. Planners should instead measure how developments could change the level of access for residents. Rejecting new developments that put more residents close to jobs—or more jobs close to residents—due to traffic fears might be short-sighted, because people's access to jobs, goods, and services increases with density, even if nearby congestion increases. Rather than increasing capacity, dense urban neighborhoods cope with congestion by using alternative modes, such as transit, bikes, and walking.

WHAT IS THE BENEFIT?

Given the scale and costs of infrastructure investments, urban planners and transportation professionals need a better understanding of the links between the transportation network and economic performance. Urban congestion does not necessarily drive away business and stifle economic productivity. In can do the opposite by clustering economic and social benefits, making a region more attractive. Emphasizing accessibility rather than just mobility produces more meaningful measures of the economic effects of traffic congestion. Access-focused development broadens how to approach capacity improvements and manage costs and traffic demands. Traveling at high speeds in and of itself does not affect one's ability to reach work, friends, stores, or recreational activities.

LEARN MORE

To view the final report:
www.its.ucla.edu/wp-content/uploads/sites/6/2016/08/Taylor-Not-so-Fast-04-01-2016_final.pdf



The relationship between proximity to jobs and job accessibility (left) and local area traffic speeds and job accessibility (right) in the San Francisco Bay Area. Job density is directly proportional to job access (shorter distances) and inversely proportional to average travel speed.

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Caltrans Division of Research, Innovation and System Information

Research Results

Eco-Driving Feedback for Freight Trucks

Driver feedback technology can improve fuel efficiency and reduce emissions

Planning/ Policy/ Programming

FEBRUARY 2017

Project Title:
Environmentally-Friendly Driving Feedback Systems Research and Development for Heavy-Duty Trucks

Task Number: 2822

Start Date: October 1, 2014

Completion Date: March 31, 2016

Product Category: New or improved business practice, procedure, or process

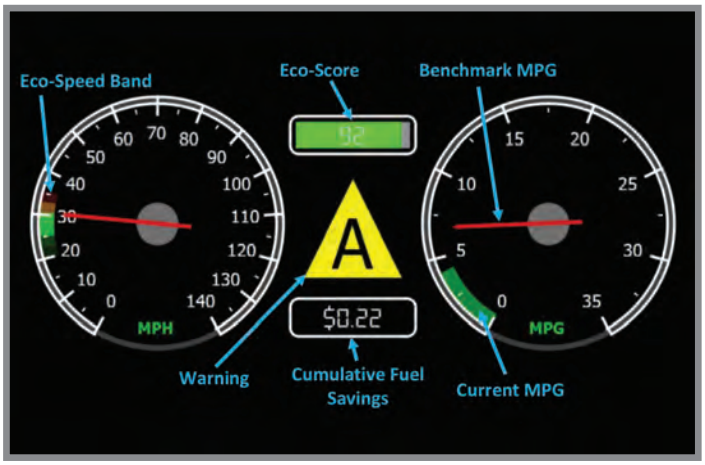
Task Manager:
Lauren Iacobucci
Associate Transportation Planner
lauren.iacobucci@dot.ca.gov

WHAT WAS THE NEED?

In the United States, trucks move approximately 70% of freight. A typical commercial truck consumes over 20,000 gallons of fuel each year, accounting for about 30%–40% of the total operating cost, and produces a large amount of greenhouse gas (GHG) emissions in the process. In California, medium- and heavy-duty trucks contribute more than one-fifth of the transportation sector's GHG emissions. In tandem with the trucking industry's interest in reducing fuel consumption and costs, the state wants to reduce emissions from trucking operations. Encouraging "eco-driving" can be a cost-effective strategy to improve trucks' environmental performance. The core of eco-driving programs is to provide drivers advice and feedback to reduce fuel consumption through education, training, and in-vehicle driving advisory systems. The University of California, Riverside College of Engineering–Center for Environmental Research and Technology (CE-CERT) developed driver feedback technologies for light-duty cars. Research was needed to apply these technologies to commercial trucks and determine their potential at improving fuel efficiency and reducing emissions.

WHAT WAS OUR GOAL?

The goal was to evaluate whether a driving feedback system for truckers is an effective strategy for reducing fuel consumption and the associated emissions.



Eco-driving feedback interface

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Eco-Driving Feedback for Freight Trucks

Research Results

WHAT DID WE DO?

Caltrans, in partnership with the National Center for Sustainable Transportation, sponsored the CE-CERT researchers to adapt the eco-friendly driver feedback technology developed for automobiles. The system consists of:

- Navigation technology that determines the most fuel-efficient route for a trip, taking historical and real-time traffic and roadway conditions into account
- Real-time eco-driving feedback, such as warnings regarding excessive speed and aggressive acceleration and recommended driving speed for fuel efficiency
- Evaluations that score how eco-friendly the driving is and generate recommendations for improving performance

The project recruited 22 professional truck drivers to use the eco-routing navigation technology, implemented as a mobile app, to study route choice preference by comparing the shortest, fastest, and most fuel-efficient routes for 14 trip scenarios. The researchers implemented a state-of-the-art truck driving simulator with the eco-driving feedback technology and programmed a typical Southern California freight trip to test the drivers' responses.

WHAT WAS THE OUTCOME?

Using the eco-routing navigation technology, the participants selected the most fuel-efficient route 38% of the time, which is low based on the conventional behavior theory that travelers try to minimize their overall travel costs, a large part of which is travel time. The differing behavior could be because several participants are employed by companies as opposed to being independent operators, so travel time spent on the job might not be regarded as a personal cost.

Participant using the eco-driving feedback technology in truck driving simulator

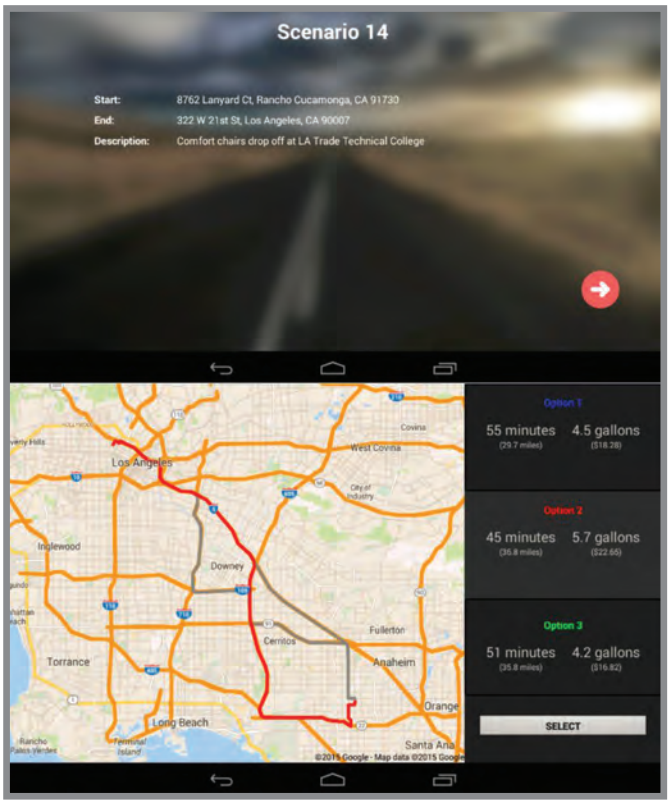
The eco-driving feedback helped drivers reduce fuel consumption by 11%, resulting in an 8% reduction of both oxides of nitrogen emission and fine particulate matter emission. The eco-scores calculated for all participants in the experiment showed that on average the eco-driving feedback technology improved acceleration by 9%, braking by 7%, and speed by 3%.

WHAT IS THE BENEFIT?

The initial research shows that feedback systems can change driving habits to improve fuel efficiency. The scoring system helps fleet managers monitor performance and make adjustments to training and policies. Fuel savings not only lowers operating costs but also contributes to meeting California's GHG reduction targets.

LEARN MORE

To view the complete report:
ncst.ucdavis.edu/wp-content/uploads/2014/08/06-08-2016-NCST-UC-Riverside-Eco-Driving-Trucks-Final-June-2016.pdf



Eco-routing navigation app adapted for heavy-duty trucks

DRISI

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Research Results

Do Employment Sub-Centers Influence Household VMT?

Bringing employment closer to residents is a key factor in reducing vehicle miles traveled

Planning/ Policy/ Programming

MAY 2017

Project Title:
Urban Spatial Structure and the Potential for Reducing Vehicle Miles Traveled

Task Number: 2832

Start Date: August 15, 2014

Completion Date: April 1, 2016

Product Category: New or improved decision support tool, simulation, model, or algorithm

Task Manager:
Patrick Tyner
Associate Transportation Planner
patrick.tyner@dot.ca.gov

WHAT WAS THE NEED?

California's Senate Bill 375, passed into law in 2008, requires Metropolitan Planning Organizations to develop more sustainable regional transportation and housing strategies. The Los Angeles metropolitan area is in the midst of a major rail transit construction program, and the area's transportation plans, as for other state metropolitan areas, are tied to understanding the relationship between land use and travel behavior to support policies that promote transit-oriented development and alternatives to automobile travel. Studies on land use indicate that travel has a larger association with employment access than population density. Yet the employment access variables in the research literature do not differentiate between whether drivers have access to jobs that are clustered in an employment sub-center or dispersed across the region. Clustering jobs can alter the economic geography of a region and affect trip generation and trip chaining. California metropolitan areas have highly sub-centered employment patterns, but policymakers are using resources that do not address how employment sub-centers could influence vehicle miles traveled (VMT) as compared to jobs that are not in sub-centers.

WHAT WAS OUR GOAL?

The goal was to examine whether and how access to jobs in employment sub-centers affects household vehicle miles traveled to assist in metropolitan land-use planning and transportation policies.

Study area: Los Angeles, Orange, Riverside, San Bernardino, and Ventura counties

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Do Employment Sub-Centers Influence Household VMT?

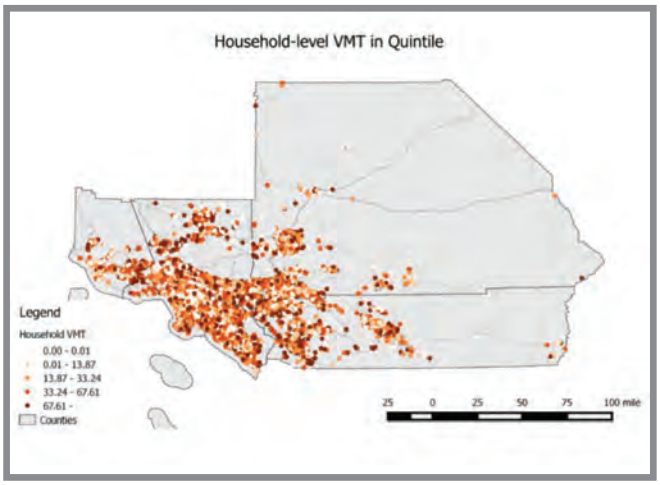
Research Results

WHAT DID WE DO?

Caltrans, in partnership with the National Center for Sustainable Transportation, chose the five-county Los Angeles Combined Statistical Area (CSA)—Los Angeles, Orange, Riverside, San Bernardino, and Ventura—with nearly 18 million people, roughly 48% of the state's population, to investigate whether the location of jobs in employment sub-centers as compared to jobs that are not affects household VMT. The study, conducted by researchers at the University of Southern California, used the 2009 National Employment Time Series database to identify the 46 employment sub-centers in the Los Angeles CSA and the 2012 California Household Travel Survey to measure household VMT. The researchers modified a standard land-use, travel-behavior regression to include job location and access as explanatory variables.

WHAT WAS THE OUTCOME?

In general, placing jobs near residents, and residents near jobs, is a good strategy for reducing VMT in all parts of the Los Angeles CSA. Jobs that are within five miles of households have the largest association with reduced VMT, and that distance is more important than whether the jobs are in or outside of employment sub-centers. Accessibility to work outside employment sub-centers often has a larger impact on VMT than jobs inside the sub-centers, although the effect on household VMT varies in core counties and peripheral counties. Improved employment access is likely a key factor in the lower levels of driving seen in central versus peripheral locations. The regression results predict that households in outlying areas drive more than households who live closer to the urban center.



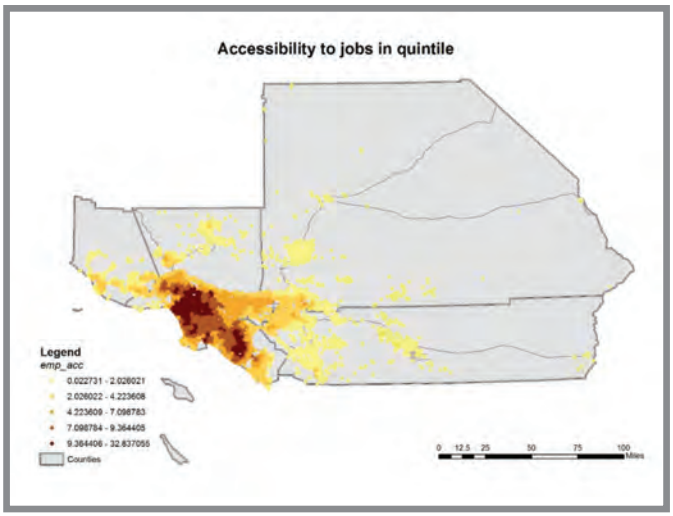
Spatial distribution of VMT of the households in the Los Angeles CSA

WHAT IS THE BENEFIT?

To implement California's mandate to reduce greenhouse gas emissions, more relevant information on the links between the spatial distribution of jobs and households is needed. This research addresses the understudied sub-centered employment structure of California's metropolitan areas and provides policy makers, transportation planners, and municipal governments guidance on how job location influences VMT and helps focus land-use strategies that improve short-distance access from residential locations to employment.

LEARN MORE

To view the complete report:
www.metrans.org/sites/default/files/research-project/NCST%20Urban%20Spatial%20Structure%20Boarnet%20%204_10_16_CaltransVersion_smFile_v2.pdf



Spatial distribution of the same households based on the employment accessibility variable, used to measure the impact of the employment sub-centers on individual household VMT

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Research Results

Expanding the Network of Electric Vehicle Charging Stations

Analyzing travel patterns and driver behavior to strategically locate charging stations to encourage and support EV adoption

Planning/ Policy/ Programming

FEBRUARY 2017

Project Title:
Strategic Charging Infrastructure Deployment for Electric Vehicles

Task Number: 2799

Start Date: March 1, 2015

Completion Date: April 15, 2016

Product Category: New or improved decision support tool, simulation, model or algorithm

Task Manager:
Lauren Iacobucci
Associate Transportation Planner
lauren.iacobucci@dot.ca.gov

WHAT WAS THE NEED?

The transportation sector is accountable for more than 20% of CO_2 emissions worldwide and about 30% in the United States. To reduce greenhouse gas emissions, cleaner electric vehicles (EV) are a viable alternative to conventional internal-combustion engines. Other potential benefits include lower operating and maintenance costs and reduced or no dependence on gasoline. But consumers are reluctant to switch to EVs because of their short battery range and the lack of a charging infrastructure. Strategically locating charging stations while taking driver behavior into account is an essential step toward broader adoption of EVs and improving the electrification rate of vehicle miles traveled (eVMT).

WHAT WAS OUR GOAL?

The goal was to employ a data-driven approach to optimize the location and size of charging stations and determine their economic feasibility as consumers consider EV adoption in light of a developing charging infrastructure.

Charging station

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WHAT DID WE DO?

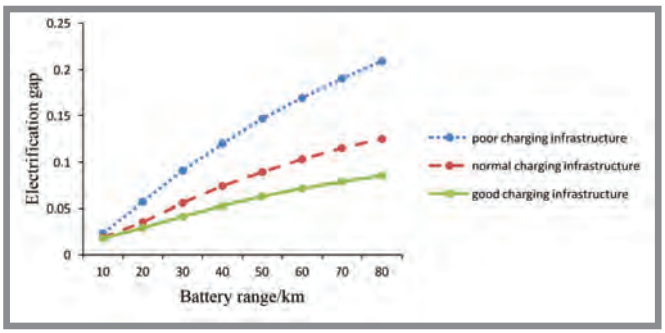
Caltrans, in partnership with the University of California Center on Economic Competitiveness in Transportation (UCCONNECT), gathered real-time vehicle trajectory data of 46,765 plug-in electric vehicle (PHEV) taxis in Beijing, China, for two months to obtain the travel patterns of individual drivers and their public recharging behavior to determine optimal station locations. The UC Berkeley researchers chose the Beijing taxi fleet because it provided a large sample size to more effectively apply big data mining techniques to quantitatively depict the relationship between eVMT, battery range, and the deployment of public charging stations. To increase eVMT, the researchers suggested policy guidelines for planning a public charging infrastructure deployment, including location, the number of chargers at each station, and their charging speed.

WHAT WAS THE OUTCOME?

Recharging a PHEV battery is time consuming, and the times drivers choose to recharge overlap. The researchers developed a simulation model that defines whether a charging station is economical by taking into account the charge time window, charging demand, and charger availability while incorporating the heterogeneous travel patterns of individual vehicles.

To encourage EV adoption, the study found:

- When the public charging infrastructure is not sufficient, incentivize home charging.
- Combine fast and slow chargers at stations. Although a fast charger is 10 times more efficient, the deployment cost and demands on the electrical circuit are also higher.
- Design smaller charging stations and spatially distribute them.
- Create an intelligent guidance system that informs drivers of the availability of chargers.



The influence of the charging infrastructure's quality

WHAT IS THE BENEFIT?

Understanding drivers' charging behavior and travel patterns under different conditions helps planners determine whether a charging station location is economical. Designing a robust charging station network facilitates the adoption of EVs, but to truly increase eVMT, the network must be established before vehicles are introduced in full scale so that drivers can confidently drive distances. Widespread use of EVs extends beyond reducing vehicle emissions. Encouraging drivers to charge vehicles during off-peak periods spreads the demand for electricity, making better use of the energy-generating infrastructure. By developing a smart grid, vehicle batteries can store energy at periods of low demand and then feed back to the grid at peak periods, mitigating the need of peaking plants.

LEARN MORE

To view the complete report:
escholarship.org/uc/item/2rr92202

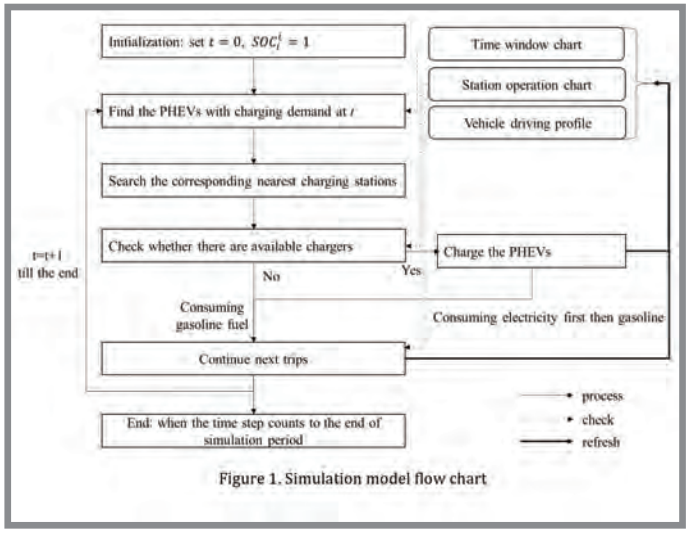


Figure 1. Simulation model flow chart

Simulation model flow chart

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Research Results

California Fuel Tax Swap of 2010

An analysis of the causes, effects, and projections of the restructuring of the revenue sources for transportation programs

Planning/ Policy/ Programming

FEBRUARY 2017

Project Title:
Impacts and Future of the California Fuel Tax Swap of 2010

Task Number: 2797

Start Date: February 15, 2014

Completion Date: April 30, 2016

Product Category: New or improved decision support tool, simulation, model, or algorithm

Task Manager:
Scott Williams
Associate Transportation Planner
k.scott.williams@dot.ca.gov

WHAT WAS THE NEED?

In 2010, the California legislature enacted a new tax structure for motor fuels—the so-called "fuel tax swap"—to create more flexibility to close a near $20 billion budget gap. Before the tax swap, gasoline was subject to a per-gallon excise tax and a state sales tax on the purchase price. The restructuring eliminated the sales tax, and the excise tax was raised to offset the lost revenue from the discontinued sales tax. The intent was to shift the source of the tax but not the amount that consumers paid, because most gas-pump sales tax revenue was earmarked for transit agencies, but the excise tax did not have these restrictions. The revenue collected from the excise tax could then be used in the general fund.

Because of the change in allocation of the collected fuel tax to non-transportation purposes, and as state- and federal-level expenditures for transportation continue to decline, financial responsibility to fund transit projects has increasingly shifted to local governments. In California, 19 communities have adopted a voter-approved local option sales tax (LOST) to fund transportation projects. However, fuel and sales taxes are considered regressive because lower income households tend to pay a larger share of their income for the taxes than higher income households. Increasing the local sales tax to finance transportation also means that light users of transit systems tend to pay more per mile traveled than heavy users. But ultimately, the degree of regressivity depends on how the revenues are spent. When funds go to projects and services that benefit lower income households, the LOST becomes more progressive. To achieve a more equitable tax structure that supports maintaining and improving California's transportation and transit systems, this research analyzed the effects of the 2010 fuel tax swap, the collection of revenues by LOSTs, and how the expenditures of funds serve the various communities.

WHAT WAS OUR GOAL?

The goal was to analyze how the change in California transportation revenue collection affects the equity of and funding for transportation programs and public transit and assess the extent to which projects will benefit low-income households.

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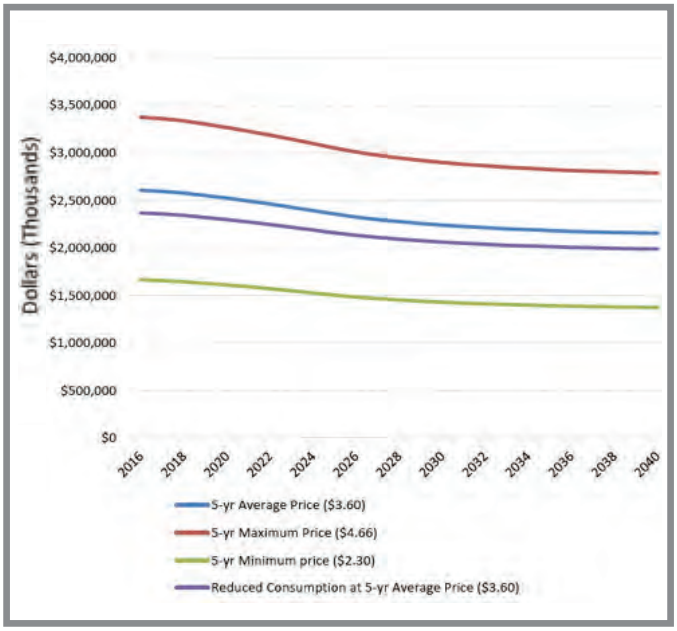
WHAT DID WE DO?

Caltrans sponsored the University of California Center on Economic Competitiveness in Transportation (UCCONNECT) to analyze the change in California transportation revenue collection programs, the effect since the fuel tax was implemented, whether the changes that occurred are consistent or differ from what was anticipated, and the likely impacts on revenue and transportation finance in the coming years. The UCLA researchers delved into the complexity of funding transportation in California over the past decades, the various types of automobile-related revenues that are collected, and how these monies are distributed and then documented the information for a general audience.

OUTCOME

The California Legislative Analyst's Office, Department of Finance, and Caltrans agree that revenue streams under the fuel tax swap are challenging to predict accurately from year to year because the excise tax is variable. As a result, the fluctuating transportation revenues have exacerbated and challenged planning continuity in transportation programs, which are typically multi-year programs that rely on steady and predictable funding streams.



Forecast of variable gasoline excise tax revenues

WHAT IS THE BENEFIT?

The intent of this study is to improve public awareness of the equitability of California transportation financing by making the history, structuring, and decisions more accessible to legislators, media, and agencies involved in transportation programs. The research will help decision-makers better understand how projects are funded via the state and local communities, assess the regressivity of the tax structure, and how broadly the benefits extend to the population at large.

LEARN MORE

To view the report:
www.its.ucla.edu/publication/the-california-fuel-tax-swap

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Research Results

Precision Mapping of the California Connected Vehicle Test Bed

Mobile positioning and mapping systems provide precise positioning of road features

Research Support

JANUARY 2017

Project Title:
Precision Mapping of the California Connected Vehicle (CV) Test-Bed Corridor

Task Number: 2777

Start Date: June 23, 2015

Completion Date: September 30, 2015

Product Category: New or improved decision support tool, simulation, model, or algorithm

Task Manager:
Asfand Siddiqui
Transportation Engineer
asfand.siddiqui@dot.ca.gov

WHAT IS THE NEED?

As part of the Federal Highway Administration's Exploratory Advanced Research Program, researchers have developed hardware and software tools to map roadway features at decimeter-level accuracy. Precise mapping is a necessary component of intelligent transportation system applications that rely on lane-level positioning of vehicles. Over the past several years, several research programs have used the California Connected Vehicle Test Bed corridor to evaluate automated and connected vehicle (CV) technologies and applications. These projects have required a precise map to inform vehicles which lane they are in and exactly how far they are from the intersection.

WHAT WAS OUR GOAL?

The goal was to develop a precise map of the California Connected Vehicle Test Bed to support intelligent transportation system research.

Mapping unit with GPS and lidar unit

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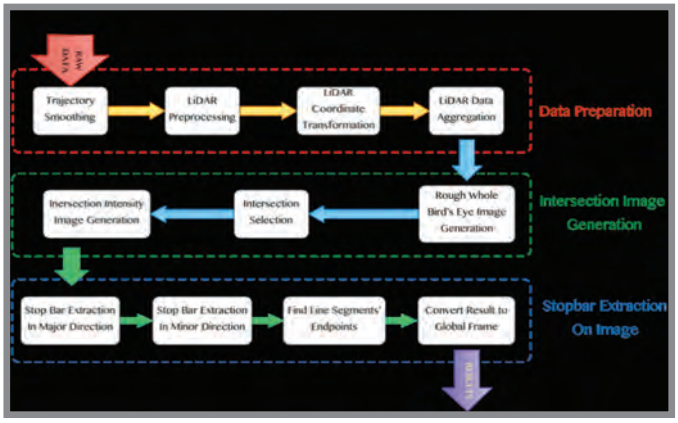
Precision Mapping of the California Connected Vehicle Test Bed

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Riverside Center for Environmental Research and Technology, instrumented a probe vehicle with a mobile positioning and mapping sensor to obtain precise positioning and mapping data of the California Connected Vehicle Test Bed. The mobile mapping system incorporates GPS technology, vision sensors (lidar and radar), and high-rate kinematic sensors to capture and process multiple location and feature-based signals and to bridge data gaps when sensor reception is interrupted. The vehicle was driven repeatedly up and down the corridor at different times of the day, with varying levels of congestion, collecting raw point-cloud data on the on-board data servers. At the end of each data run, the raw data was examined to determine its validity, which guided the ongoing data collection process. The raw point-cloud data was then processed, extracting features important to vehicle guidance, along with their precise positions.

WHAT WAS THE OUTCOME?

The researchers precisely mapped the California Connected Vehicle Test Bed, including lane markings, intersection features, and stop bars. The next steps are to formalize the process and to extend the work with more elaborate feature-extraction algorithms.



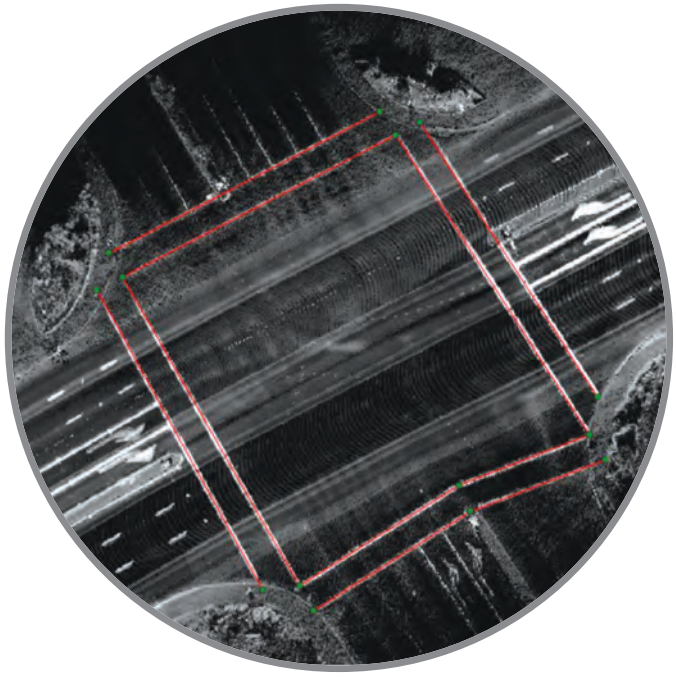
Data processing of the mobile mapping system

WHAT IS THE BENEFIT?

The designed hardware, software, and algorithm make it easier to collect data on intersection features, helping developers to acquire the necessary information for connected vehicle applications with the least amount of time and resources.

LEARN MORE

To view the final report:
http://www.dot.ca.gov/research/researchreports/reports/2015/CA16-2777_FinalReport.pdf



Extracted stop bar in red on the point cloud

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Research Results

Enhanced Responder System for Incident and Emergency Management

First responders can collect and share at-scene information in real time, even when communication is limited

Rural

MARCH 2017

Project Title:
Development and Testing of Responder Phase III

Task Number: 1846

Start Date: July 1, 2012

Completion Date: December 31, 2015

Product Category: New or improved tool or equipment

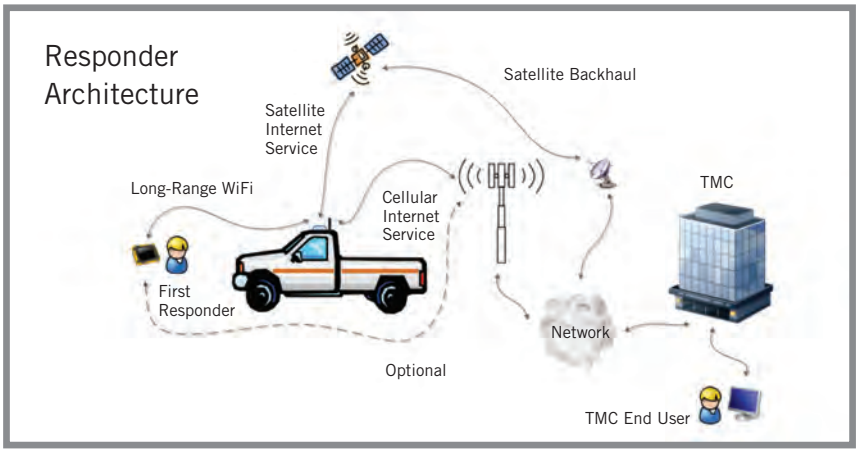
Task Manager:
Melissa Clark
Transportation Engineer, Electrical
melissa.clark@dot.ca.gov

WHAT WAS THE NEED?

Caltrans maintenance staff are often some of the first responders to incidents on the state's roadways. They collect information, determine the appropriate response, and access and manage resources at the scene. In most districts, emergency responders rely on voice communications to exchange information with their transportation management center (TMC) and other personnel. However, many rural districts have areas with limited or no communication, including no two-way radio and cellular coverage. During an incident, rural first responders need a reliable means to transmit and access photos, drawings, weather conditions, and maps to and from other responders and the TMC to ensure that the correct resources are efficiently dispatched to the site.

WHAT WAS OUR GOAL?

The goal was to update the responder system using off-the-shelf technology to provide incident responders, particularly those in rural areas with sparse communication coverage, with a reliable tool to collect and send at-scene information.



The system connects to the most efficient and available communications service to send and receive information to and from the TMC.

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Enhanced Responder System for Incident and Emergency Management

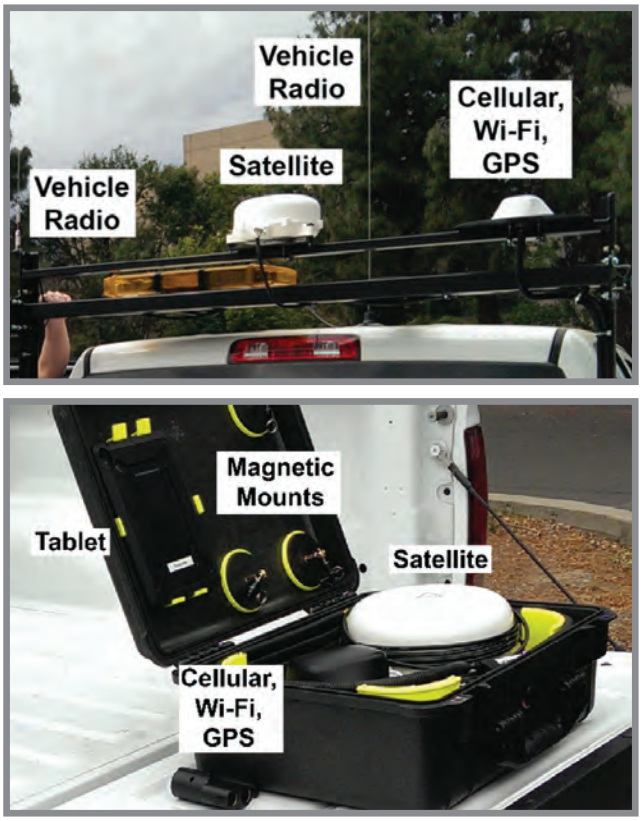
Research Results

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Davis Advanced Highway Maintenance and Construction Technology Research Center, prototyped the third generation of the incident responder system, which operates on a smart device, such as a tablet or smartphone. Users can capture, annotate, and transmit images and get vital information to keep staff safe while responding to an emergency. The system connects to the most efficient and available communication service, such as cellular, Wi-Fi, or satellite. Based on GPS readings, the tool downloads local weather conditions and forecasts, retrieves maps and aerial photos, pinpoints the responder's location on the maps, and provides surrounding roadway information and access.

WHAT WAS THE OUTCOME?

Two prototypes with the same components were developed: a fixed version that is installed in a Caltrans maintenance vehicle and a mobile version that can be transported in a suitcase. The system uses readily available commercial hardware to support wide deployment, and customization is not required. The responder system uses minimal bandwidth to transfer data and does not need a continuous connection to the TMC. Its ease of use allows responders to concentrate on work at the scene without being burdened with complex data input and reporting. Responders can send an incident form with images to the TMC where staff can assess the report to make more educated decisions and send the most appropriate resources.



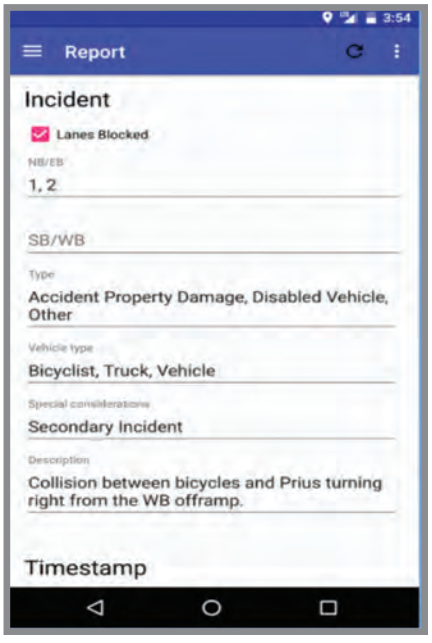
Top: The responder system is installed on a Caltrans maintenance vehicle. Bottom: The mobile version fits into a suitcase for easy transport.

WHAT IS THE BENEFIT?

The responder system supports getting the right equipment and personnel promptly dispatched to an incident. Regardless of location, first responders can collect and share at-scene information quickly and efficiently via photos, annotated images, and reports. The predesigned forms offer guidance in the type of information that the TMC needs to evaluate the incident, which is especially helpful for personnel new or inexperienced with a certain situation. Responders can also get essential information that can influence decisions, such as weather conditions, potential hazards, and road closures.

LEARN MORE

To view the report:
ahmct.ucdavis.edu/projects/responder



The responder enters the incident details and then clicks Send Email. The system composes an email message and sends it to the TMC operator and other parties.

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Caltrans Division of Research, Innovation and System Information

Research Results

Improving Seismic Safety of Cut and Cover Tunnels

Designing subsurface, earth-covered tunnels to withstand seismic loading requires different considerations than above-ground structures

Seismic

MARCH 2017

Project Title:
Seismic Assessment of Cut and Cover Tunnels

Task Number: 2420

Start Date: November 30, 2011

Completion Date: July 31, 2015

Product Category: New or improved technical standard, plan, or specification

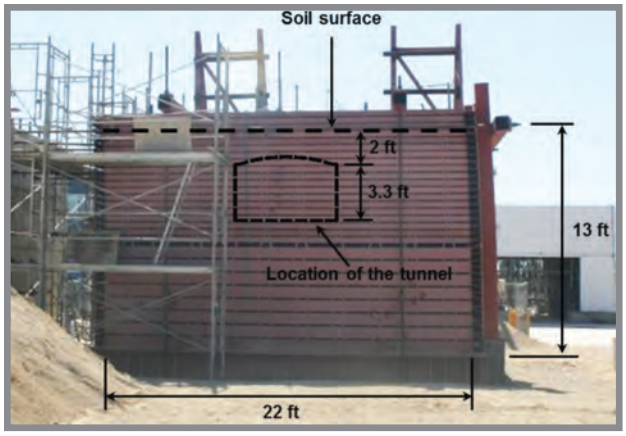
Task Manager:
Charles Sikorsky
Research Program Manager
charles.sikorsky@dot.ca.gov

WHAT WAS THE NEED?

Increasing urban traffic and a lack of open space to expand surface streets and public transit has resulted in cities across the country building subsurface roadway tunnels. Cut-and-cover tunnels are constructed with a shallow earth cover to improve the environmental impact of roads and railway lines. The covering offers noise reduction, better integration with the landscape, and continuity of the ground surface. Typically, the shallow tunnels use a rectangular, box-shaped frame that does not efficiently transmit static loads, so the walls and slabs must be thicker, leading to increased structural stiffness. For seismically active regions, the structures need to be designed to resist ground motions. The seismic response of the underground structure is governed by larger deformation and inertial responses of the surrounding soil. In addition, the soil backfill can consist of compacted material with different properties from the in-situ soil, resulting in a unique seismic response. Much research has been done on bored deep tunnels, mainly in rock, but little is available on shallow tunnels embedded in soft soils. Research is needed to address the seismic response characteristics of the reinforced-concrete tunnel structure and the ground-tunnel soil-structure interaction to establish an appropriate seismic design for cut and cover tunnels.

WHAT WAS OUR GOAL?

The goal was to experimentally validate engineering procedures for use in the development of seismic design guidelines for cut and cover tunnels.



Laminar soil shear box test under quasi-static loading

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Improving Seismic Safety of Cut and Cover Tunnels

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Davis School of Engineering, analyzed the seismic performance of cut-and-cover tunnels with a quasi-static cycling loading test on a one-third scale model of the San Francisco Doyle Drive Battery Tunnel and documented the tunnel's lateral stiffness and large deformation response characteristics. This assessment provided the elastic stiffness of the subsequent experimental tunnel models to investigate the associated soil-structure response. The researchers then conducted pushover tests on a one-ninth scale ground-tunnel model in a laminar soil container to study the interaction between the tunnel liner and the surrounding ground. On the basis of these test results, the researchers calibrated a finite-element (FE) model to assess the system dynamic response during earthquake simulations with varying key parameters, such as soil properties, embedment depth of the tunnel, and earthquake characteristics.

WHAT WAS THE OUTCOME?

The FE simulation results were compared to the 2009 Federal Highway Administration (FHWA) guidelines and revealed ranges of applicability and potential under- and overestimation when using the FHWA procedure. The FHWA method can significantly overestimate the racking deformation, or drift, compared to the numerical analysis. As the intensity of the earthquake excitation increased, the earthquake-induced shear stress approached the soil shear strength, leading to a greater extent of the racking overestimation. The FHWA simplified procedure for estimating lateral tunnel stiffness appears to be adequate, except for situations of soil shear stress approaching the available soil shear strength. For such potentially large racking scenarios, the tunnel stiffness will be generally lower than the FHWA estimate. The FHWA procedure is generally of value for situations where the estimated soil shear strain is relatively low. In such cases, the tests showed to use the soil properties at the level of the tunnel base (for relatively cohesionless soils) rather than those at the tunnel mid-height, according to the FHWA procedure. This research provided preliminary recommendations pending further analysis and large-scale experimental work to be completed under Task 2561.

One-ninth scale steel tunnel to assess the interaction between the tunnel liner and the surrounding ground

WHAT IS THE BENEFIT?

Cut-and-cover tunnels are increasingly a preferred solution for transportation challenges in California. The research provides calibrated and reliable assessment tools and approaches to ensure that these structures are designed and constructed in a seismically resistant and efficient manner.

LEARN MORE

Report forthcoming.

One-third scale model of the reinforced-concrete Doyle Drive Battery Tunnel

DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Designing Better Shear Keys for Bridge Abutments

Improving the seismic performance of shear keys in bridge structures reduces damage and cost

Seismic

MARCH 2017

Project Title:
Evaluation and Improvement of Design Methods and Details for Shear Keys and Stem Walls in Bridge Abutments

Task Number: 2263

Start Date: October 1, 2010

Completion Date: September 30, 2015

Product Category: New or improved technical standard, plan, or specification

Task Manager:
Charles Sikorsky
charles.sikorsky@dot.ca.gov

WHAT WAS THE NEED?

Shear keys are used in bridge abutments to provide lateral restraints under normal service loads and moderate earthquake forces. In the event of a severe earthquake, shear keys are designed to function as structural fuses to prevent transmitting large seismic forces to the abutment piles. In California, either isolated or non-isolated shear keys are used in bridge abutments. An isolated shear key is separated from the stem wall with a construction joint and connected with vertical reinforcing bars. A non-isolated shear key is cast monolithically with the stem wall and is more economical to construct. To resist failure, shear keys and abutment stem walls require an accurate assessment of their load capacities associated with the different failure mechanisms. However, the exact influence and performance of abutment shear keys during a seismic event is not well understood. Research was needed to develop analytical methods to determine the lateral load capacities of shear keys to understand their influence on the seismic performance of bridge structures and to maximize their effectiveness while minimizing the repair cost.

WHAT WAS OUR GOAL?

The goal was to develop a rational design procedure for abutment shear keys to improve their effectiveness and performance during seismic events.

Test of a non-skewed shear key (left) and skewed shear key (right)

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Designing Better Shear Keys for Bridge Abutments

WHAT DID WE DO?

Caltrans, in partnership with the University of California, San Diego Department of Structural Engineering, tested six shear key-stem wall assemblies, with two shear keys in each assembly. One specimen had two isolated shear keys to investigate the influence of the surface condition of the construction joint—smooth versus rough—on the resistance of the shear key. Four specimens had non-isolated shear keys, one of which had a 60-degree skew. One test specimen had post-tensioned shear keys, designed with an innovative concept that allowed the shear keys to rock to improve their displacement capacity.

WHAT WAS THE OUTCOME?

The concrete strength, the amount of vertical dowel bars, the surface roughness and bond breaker in the construction joint, the inclination of the loaded face of the shear key, and the angle of skew can all influence the resistance of the shear key. The resistance of a shear key with a 60-degree skew can be significantly weaker than a shear key that has no skew and the same amount of vertical dowel reinforcement.

The study has shown that stem walls and shear keys in bridge abutments can be designed and reinforced to prevent the diagonal shear failure of a stem wall even if the shear keys are not isolated from the stem wall with construction joints. Non-isolated shear keys and isolated shear keys with rough construction joints can develop much higher resistance than isolated shear keys with smooth construction joints due to the aggregate interlock mechanism and the higher coefficient of friction and cohesive force. However, they can also have more severe cracking than isolated shear keys. Post-tensioned rocking shear keys can develop ductile behavior with a much higher displacement capacity than isolated and non-isolated shear keys and have good potential for use in practice.

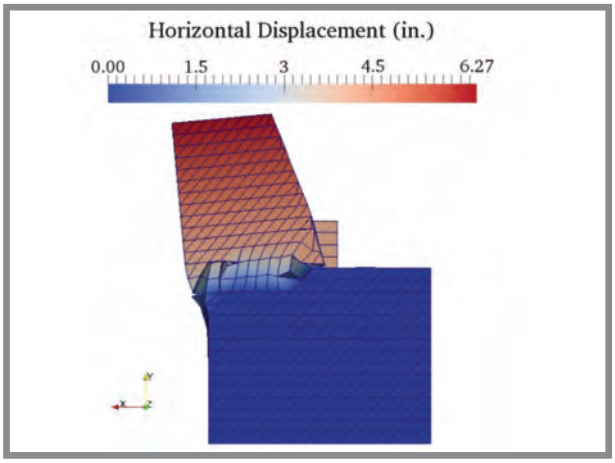
Failure behavior of a non-isolated shear key

WHAT IS THE BENEFIT?

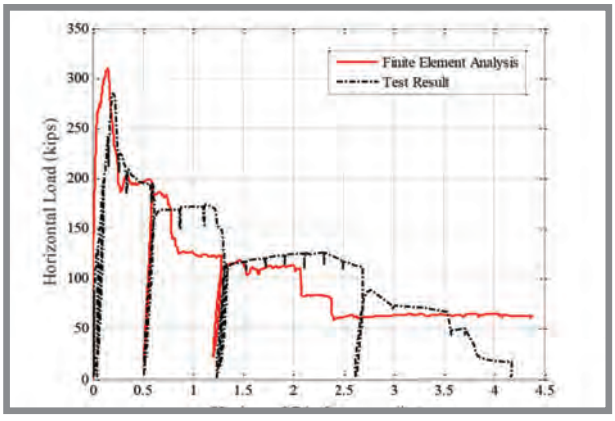
This research has produced simplified analytical methods to accurately assess the seismic load demand on shear keys in bridge abutments and their lateral load resistance to avoid undesired failure modes. The shear keys function as a structural fuse, preventing the transmission of excessive seismic forces to abutment piles and reducing damage after a major seismic event. The methods are readily implementable in the Caltrans Seismic Design Criteria. The newly developed post-tensioned shear key concept could significantly reduce earthquake-induced damage and repair costs.

LEARN MORE

To view the complete report:
www.dot.ca.gov/hq/research/researchreports/reports/2016/CA16-2263_FinalReport.pdf



Finite element modeling of a non-isolated shear key



Comparison of experimental and numerical load versus displacement curves

DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Determining the Expected Stress-Strain Behavior of A706 Grade 80 Rebar for Seismic Applications

Testing expands the knowledge of the required minimum and maximum strength requirements to meet seismic design criteria

Seismic

JANUARY 2017

Project Title:
A706 Grade 80 Reinforcement for Seismic Applications

Task Number: 2563

Start Date: February 1, 2013

Completion Date: September 30, 2015

Product Category: New or improved technical standard, plan, or specification

Task Manager:
Charles Sikorsky
Research Program Manager
charles.sikorsky@dot.ca.gov

WHAT WAS THE NEED?

When designing reinforced concrete structures to resist earthquake-induced forces, the materials need to behave as anticipated. The steel reinforcement must possess large inelastic strain capacity (ductility) and sufficient strain hardening to dissipate energy. Therefore, the steel reinforcement must adhere to both specific minimum and maximum strength requirements. Steel rebar is manufactured to provide a specified minimum level of strength, so production mills tend to maintain an average strength that is safely above the minimum. As a result, the actual strengths are usually higher than the specified values. During seismic activity, unaccounted strength could lead to sudden, brittle modes of failure in parts of the structure not meant to undergo the increased forces. Knowledge of the materials' expected mechanical properties critically influences the design. A706 grade 80 rebar has the potential of being a valuable alternative to the currently specified A706 grade 60 rebar, but material test results were scarce.

WHAT WAS OUR GOAL?

The goal was to assess the expected stress-strain behavior of A706 grade 80 rebar through experimental testing and statistical analysis to determine whether it can be included in the Caltrans Seismic Design Criteria.

Fractured No. 8 bar

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Determining the Expected Stress-Strain Behavior of A706 Grade 80 Rebar for Seismic Applications

Research Results

WHAT DID WE DO?

Caltrans sponsored the North Carolina State University, Department of Civil Construction and Environmental Engineering to test the tensile abilities of A706 grade 80 rebar. The researchers conducted 788 tests on 10 different bar sizes, No. 4 through No. 18, in as-rolled condition. Three mills provided steel produced at different heats at no cost to the university. A non-contact 3D position measurement system simultaneously evaluated strains over multiple gage lengths for the full duration of each test, including fracture of the bar. The researchers then used the generated data to statistically determine the rebar's most probable material properties to define recommended values of stress and strain at specific key points and establish the nature of the associated stress-strain curve.

WHAT WAS THE OUTCOME?

The research produced expected values and recommendations for each of the five stress-strain parameters of interest. The recommendations for the A706 grade 80 stress-strain curve are analogous to the current Caltrans Seismic Design Criteria for the A706 grade 60 curve. The proposed grade 80 curve, however, benefits from an improved statistical basis for the associated parameter values. A sample excerpt from the SDC illustrates how A706 grade 80 rebar could be incorporated in the existing code with minimal impact on the surrounding material.

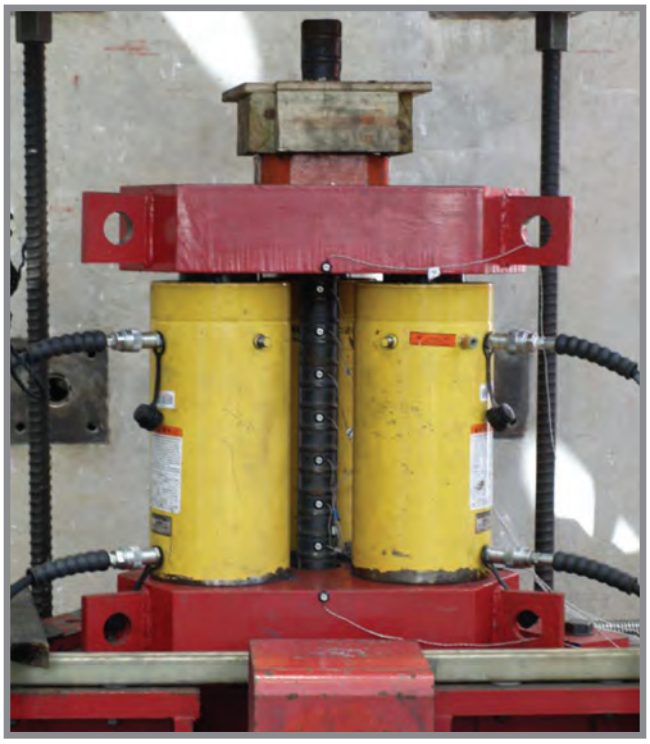
Optotrak non-contact position measurement system (left) and LED markers on bar (right) used to capture strains over multiple gage lengths. An extensometer is also attached to the back of the bar.

WHAT IS THE BENEFIT?

The research expanded the knowledge of A706 grade 80 rebar from almost nonexistent test results to an extensive dataset based on 788 tests encompassing full stress-strain behavior. The results show that the new rebar presents a valuable alternative. Using A706 grade 80 rebar in reinforced concrete structures can reduce material costs and congestion in footing and cap-beam joints because the columns could have fewer bars of the same size as compared to grade 60 steel. Additional benefits of the project include recommendations for future tensile testing programs that achieve a similar degree of reliability but using a fewer number of tests.

LEARN MORE

To view the complete report:
www.dot.ca.gov/newtech/researchreports/reports/2015/CA16-2563_FinalReport.pdf



Setup for testing large diameter bars. No. 18 bar shown with LED markers ready to be tested.

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Caltrans Division of Research, Innovation and System Information

Research Results

Developing Column-to-Shaft Pin Connections for Seismic Conditions

Pin connections can reduce the size of bridge foundations and facilitate accelerated bridge construction

Seismic

FEBRUARY 2017

Project Title:
Seismic Performance of Bridge Column-Pile-Shaft Pin Connections for Application in Accelerated Bridge Construction

Task Number: 2423

Start Date: July 5, 2012

Completion Date: November 30, 2015

Product Category: New or improved technical standard, plan, or specification

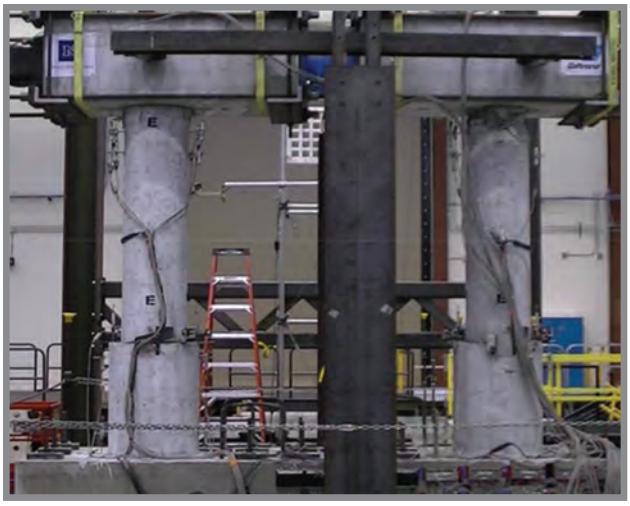
Task Manager:
Peter Lee
Research Contract Manager
PLee@dot.ca.gov

WHAT WAS THE NEED?

Cast-in-place columns with rigid connections is the prevailing bridge construction method, which requires concrete to set and cure onsite. In contrast, precast structural elements reduce construction time and disruption by eliminating onsite curing and prefabricating components in parallel. Accelerated bridge construction (ABC) relies on prefabricated bridge columns, but the conventional ABC bridge connections are designed for low-seismic zones and do not have sufficient ductility and strength to meet seismic conditions. The column connection to the pile shafts, footings, and pier caps is critical in resisting traffic and earthquake loads. For California to take advantage of ABC efficiencies, cost-effective, reliable bridge connections need to be studied. Pin, or hinge, connections can improve seismic performance and lead to smaller and more economical foundations.

WHAT WAS OUR GOAL?

The goal was to evaluate the seismic performance of three types of bridge bent connections to type II pile shafts through experimental testing and analytical modeling to facilitate accelerated bridge construction.



Column with bent with pipe-pin column-pile-shaft connection after the final test

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Developing Column-to-Shaft Pin Connections for Seismic Conditions

Research Results

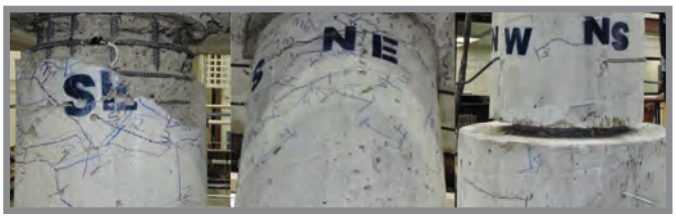
WHAT DID WE DO?

Caltrans worked with the University of Nevada, Reno Earthquake Engineering Laboratory to test two large-scale bent models built according to the Caltrans ductile design guidelines for conventional reinforced concrete bridges: one using a bent with a pipe-pin column-pile-shaft connection with a cast-in-place column, and the other using a rebar pin connection with a prefabricated column. The researchers also evaluated the damage tolerance of column plastic hinges incorporating engineering cementitious composites (ECC). For both models, the columns were connected to a precast bent cap using pocket details previously studied for ABC. For the pipe-pin model, the columns were expected to undergo plastic deformation, while the rest of the structure, including the pipe pins, were designed to remain unchanged. For the rebar pin design, only the plastic hinge in the column was expected to fail under severe earthquakes.

The shake table tests simulated the 1994 Northridge earthquake. The specimens were subjected to a series of excitations with increasing amplitudes until failure. The researchers also performed analytical studies of the test models—pushover analysis using a simple stick model, pushover analysis using a finite element model, and dynamic analysis of the shake-table tests— to validate the modeling assumptions.

WHAT WAS THE OUTCOME?

Both models failed due to fracture of the longitudinal column bars in the top plastic hinges under earthquakes that exceeded the design motion by at least 60%. In both specimens, full plastic hinge capacity was reached at the top of the column, while the pins did not fail. The damage to the pipe-pin connections was minimal. The rebar pins remained stable even under many cycles of earthquake loading. The concrete at the hinge throat was damaged, but the column and pedestal reinforcement did not yield near the rebar pins.



Damage after the final test: (left) cast-in-place column; (center) precast column with ECC; (right) precast column with rebar

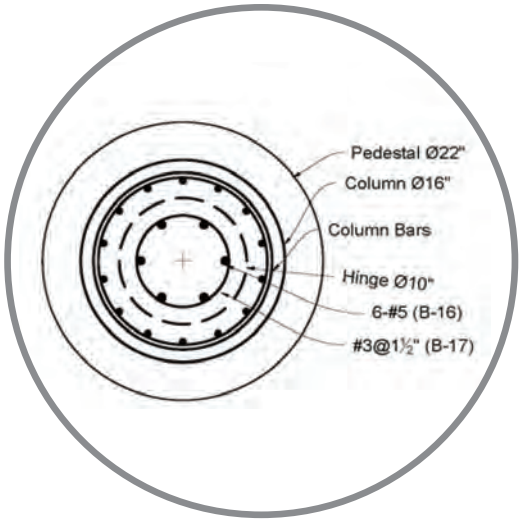
Both bents were ductile, and no difference was observed between the precast and cast-in-place pins. The pocket connections were effective to form the plastic hinge in the columns, and the precast cap beam remained elastic with no damage. The plastic hinges with ECC had significantly less damage than those with conventional concrete, even when the ECC was used only in the column shell.

WHAT IS THE BENEFIT?

Traditional cast-in-place bridge construction can disrupt traffic flow, require detours, or demand the costly use of temporary structures. Employing ABC methods can reduce disruption and cost, and the proposed pin connections advance the use of ABC in seismically prone regions. The pin connections reduce foundation force and movement, reduce the foundation size, and reduce the cost of bridge construction. These improvements will be implemented and incorporated into Caltrans design guidance materials.

LEARN MORE

To view the complete report:
wolfweb.unr.edu/homepage/saiidi/caltrans/PileShaftPin/PDFs/CCEER-16-01-MehrdadMehraein-5-4-2016.pdf



Rebar-pin detail cast-in-place two-way hinge

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Research Results

Seismic Requirements for Headed Rebar Reinforcement in Slab Bridges

Headed bar reinforcement reduces rebar anchorage length, congestion, and construction time for slab column assemblies

Seismic

APRIL 2017

Project Title:
Development Length for Headed Rebar in Slab Bridges

Task Number: 2560

Start Date: February 1, 2013

Completion Date: January 31, 2016

Product Category: New or improved technical standard, plan, or specification

Task Manager:
Charles Sikorsky
Research Program Manager
charles.sikorsky@dot.ca.gov

WHAT WAS THE NEED?

In accordance with the Caltrans Seismic Design Criteria, during a seismic event, the superstructure in a slab bridge should remain essentially elastic, and only the pile extensions or columns are permitted to develop inelastic deformations. Therefore, the longitudinal reinforcement extending from a pile extension must have sufficient embedment length in the slab to develop the full tensile strength of the bars. Using headed bars—a deformed steel bar with a head attached to one or both ends—as a replacement for straight or hooked bars in concrete members and connections can reduce the required embedment length as well as the congestion that hooked bars can introduce. According to the American Concrete Institute (ACI) 318 building code requirements, a minimum length of 14 times the bar diameter (d_b) is required for Grade 60 headed bars and 5,000-psi concrete. This specification can increase the cost of slab bridges because it could result in a thicker slab to accommodate the length. However, the ACI specification does not take into account the benefits of the vertical stirrups that are present in the bridge's slab-column joint region. An investigation was needed to determine whether the headed bar length could be reduced by taking advantage of the joint reinforcement.

WHAT WAS OUR GOAL?

The goal was to determine the minimum length needed for headed bars in a slab bridge's slab-column joint region and whether the detailing requirements for slab-column joints could be improved.

Specimen 1 used a 9.8 bar diameter embedment length for the headed bars.

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Seismic Requirements for Headed Rebar Reinforcement in Slab Bridges

Research Results

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Davis School of Engineering, tested three full-scale slab-column assemblies. Each specimen had a 2-foot diameter, 12-foot tall cast-in-place reinforced-concrete column and a 16-inch thick slab. The columns were connected to the slabs with headed bars. Specimen 1 used a $9.8d_b$ embedment length for the headed bars, and Specimen 2 used $8.7d_b$. For Specimen 3, the length was $11d_b$ and had a 3-inch drop cap in the slab to accommodate the longer development length. The models used Grade 60 steel and concrete with an expected compressive strength of 5,000 psi. The researchers also examined the influence of different design variables, such as the amount of vertical stirrups in the slab-column joints.

WHAT WAS THE OUTCOME?

The test results for Specimen 3 showed that for slab concrete with an expected compressive strength of 4,500 psi and Grade 60 steel, a length of $11d_b$ is adequate. It fully developed the plastic moment capacity of the column and provided good lateral load versus displacement hysteresis curves. It also prevented the development of severe punching cracks on the top surface of the slab. The test results for Specimen 2 indicated that an embedment length of $8.7d_b$ is sufficient to develop the moment capacity of the column, but it resulted in pinched hysteresis curves due to the more severe slip of the headed bars in the joint region. The top surface of the slab experienced severe cracks as the bars slipped under compression.

Specimen 3: Slab with drop cap

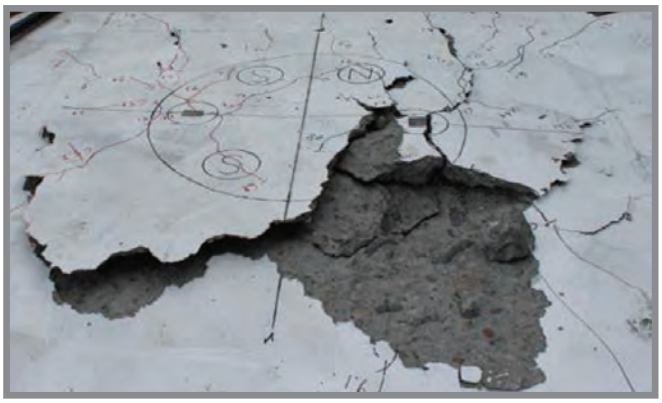
The amount of vertical stirrups in the second row and farther away from the column in the slab can be reduced. They were not effectively mobilized to resist the forces exerted by the headed bars. The bar heads should be below the top mat of reinforcement in the deck slab, and the vertical stirrups should be hooked around the top mat of reinforcement. The researchers did not investigate the effect of the concrete strength on the headed bars. Because of the lack of experimental data, an embedment length shorter than $11d_b$ is discouraged, even if the expected concrete strength is higher than 4,500 psi.

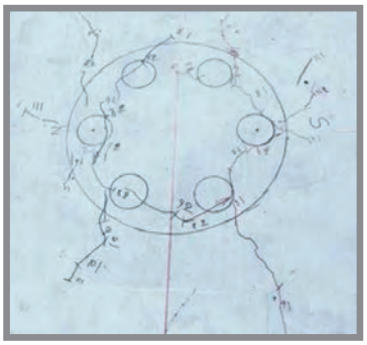
WHAT IS THE BENEFIT?

This study has shown that a development length of $11d_b$ is sufficient to securely anchor Grade 60 headed bars in the deck slabs of slab bridges that have a minimum expected concrete compressive strength of 4,500 psi, a 23% reduction of the development length required by ACI 318.

LEARN MORE

To view the final report:
http://www.dot.ca.gov/research/researchreports/reports/2015/CA15-2560_FinalReport.pdf





Damage at the top surface of the deck slab in Specimens 2 and 3

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Research Results

Collecting Travel Time Data with Bluetooth Detectors

Mountainous and rural regions use Bluetooth technology to gather real-time traffic information to assist motorists with their travel decisions

Transportation Safety and Mobility

MARCH 2017

Project Title:
Travel Time Detector Installation and Integration in District 3

Task Number: 2839

Start Date: October 15, 2014

Completion Date: August 1, 2015

Product Category: New or improved tool or equipment

Task Manager:
John Slonaker
Senior Transportation Engineer, Electrical
john.slonaker@dot.ca.gov

WHAT WAS THE NEED?

Changeable message signs along roadways and traffic-monitoring websites provide drivers with road conditions and projected travel time. To monitor traffic flow, data is collected from roadside radar and loop detectors. However, due to the geography of mountainous regions, the detectors are often miles apart or nonexistent, so getting accurate information is challenging. On US 50 in the Lake Tahoe region, weather-related conditions and the high volume of recreational visitors affect safety and travel time. Bluetooth readers installed along the highway could gather real-time information regarding average travel times between Lake Tahoe and Sacramento, allowing motorists to make an informed decision about whether to wait or get on the road.

WHAT WAS OUR GOAL?

The goal was to use Bluetooth technology to improve travel information for motorists along the US 50 corridor in the South Lake Tahoe region.

The Bluetooth reader system consists of the Iteris Bluetooth detector unit, a radio transmission device, RF cable, and antenna.

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WHAT DID WE DO?

Caltrans chose the Iteris Velocity Bluetooth reader because of price, simplicity, and its value-added software and determined that 23 locations would yield enough data to calculate travel times. Site selection was based on existing power and communications and a distance within 100 meters of the roadway to be in range of Bluetooth transmissions. The Bluetooth readers detect wireless transmissions from the mobile devices of individual vehicles and then re-identify the vehicle at a paired location along the corridor. Personal information is not collected. The data is transferred to a server to determine how long it took to travel from one reader to another. The system also performs various checks to eliminate anomalous travel times that can be caused by too few samples or communication failures. The travel time information is integrated into Caltrans' Performance Measurement System for processing and then displayed on message signs along the route and on Caltrans' Quick Map website.

WHAT WAS THE OUTCOME?

Bluetooth reader technology is a cost-effective way to determine travel times in areas that lack inductive loop detection infrastructure. Commercial systems are available and often include software to interpret the data from the field detectors into useful travel time information. The Lake Tahoe system has been in continuous operation since 2015 and has performed well considering the volume of traffic along the US 50 corridor. Both the city of South Lake Tahoe and the traveling public have responded favorably.

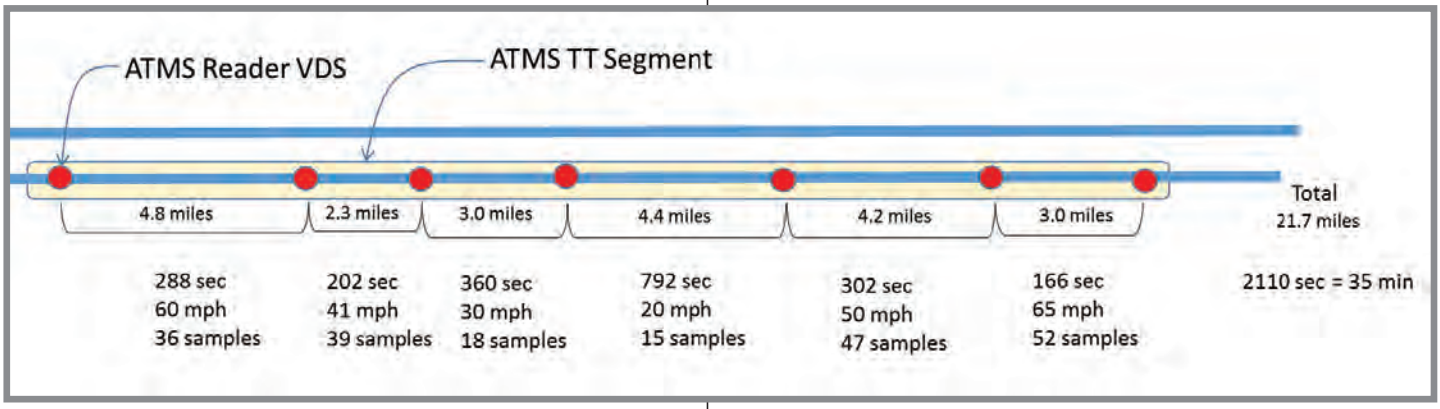
WHAT IS THE BENEFIT?

Congestion in the Tahoe region is primarily related to visitor travel patterns. Traffic incidents or bad weather conditions further exacerbate congestion during peak periods. Motorists are now informed of real-time travel conditions and can plan or alter their trip if needed. In addition to enhancing safety, the availability of travel information can reduce motorists' frustration with congestion and travel delays, improving visitors' experiences to the area.

LEARN MORE

For travel information, visit *quickmap.dot.ca.gov*.

The travel time information is transmitted to changeable message signs and the Quick Map website.



The Advanced Transportation Management System software receives the computed average travel times between pairs of Bluetooth readers and sums all the travel times to generate the total segment travel time.

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Research Results

Eco-friendly Signals Can Reduce Fuel Consumption

An in-vehicle speed advisory system communicates with actuated traffic signals to inform drivers of the most fuel-efficient speed to keep traffic flowing and minimize unnecessary stops and idling

Transportation Safety and Mobility

FEBRUARY 2017

Project Title:
Advanced Traffic Signal Control Algorithms, Phase 2

Task Number: 2529

Start Date: June 1, 2013

Completion Date: August 31, 2015

Product Category: New or improved decision support tool, simulation, model, or algorithm

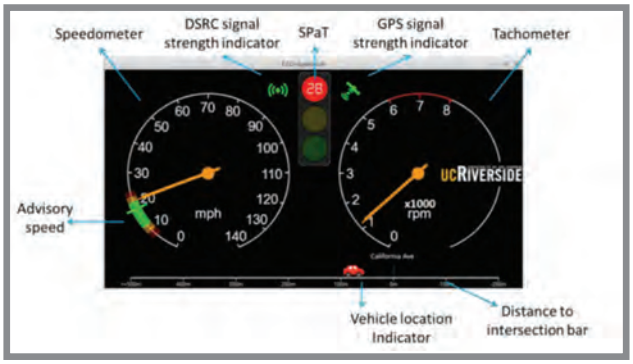
Task Manager:
Asfand Siddiqui
Transportation Engineer
asfand.siddiqui@dot.ca.gov

WHAT IS THE NEED?

In 2008, the Environmental Protection Agency required all new vehicles to comply with the on-board diagnostics (OBD) II standard. An OBD implementation can provide a range of real-time data regarding the health of a vehicle's various systems, fuel consumption, and emissions. OBD is an open standard, resulting in the availability of aftermarket adaptors and applications to enhance the driving experience. The rising cost of fuel, the global focus on reducing greenhouse gas (GHG) emissions, and the introduction of hybrid-electric and electric vehicles has fostered a growing body of research related to developing eco-driving assistants using the data available through a vehicle's OBD II port. In terms of energy and environmentally beneficial intelligent traffic system (ITS) applications, those involving traffic signals are promising in the near term, primarily because many of the supporting technologies already exist and can be readily utilized. Actuated signalized intersections that incorporate "eco-signal" operation applications and connected vehicle technologies can decrease fuel consumption and GHG emissions by improving traffic flow to reduce the number of stops and idling. To encourage eco-friendly driving, traffic signal information can be communicated to the driver via the OBD II port to minimize acceleration and deceleration events.

WHAT WAS OUR GOAL?

The goal was to implement an in-vehicle system that advises drivers to adapt the vehicle's speed in the most environmentally efficient manner when approaching an actuated signal and whether to pass through or decelerate to a stop.



In-vehicle speed advisory system

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Eco-friendly Signals Can Reduce Fuel Consumption

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Berkeley California Partners for Advanced Transportation Technology and the University of California, Riverside College of Engineering – Center for Environmental Research and Technology, designed an in-vehicle driver speed advisory system for actuated traffic signals and tested it in real-world traffic. Using Signal Phase and Timing (SPaT) and Geometric Intersection Description (GID) information, the system calculates the situational speed as the vehicle approaches an actuated signalized intersection and provides recommendations to encourage eco-friendly driving, such as whether to increase speed to make the green light, maintain speed for a light changing from red to green, or to decelerate to a stop.

WHAT WAS THE OUTCOME?

When following the in-vehicle speed advisory recommendations, the fuel saving performance varied from 0% to 22% based on the three driving scenarios: speed up to pass during green, stop when changing from green to red, and maintain speed when changing from red to green. Taking into account the occurrence chance of every scenario, the statistical results show that the real achieved benefit for the tests ranges between 3% and 4%.

WHAT IS THE BENEFIT?

Using a speed advisory system when approaching an actualized signaled intersection can reduce fuel consumption and emissions and make drivers more aware of how their driving habits affect performance. Each gallon of gasoline saved reduces 20 pounds of carbon dioxide (CO_2) from the atmosphere. In fiscal year 2014–15, California consumed about 15 billion gallons of gas. A 3% savings in fuel consumption equates to about 450 million gallons and a reduction of about nine billion pounds of CO_2.

LEARN MORE

To view the complete report:
http://www.dot.ca.gov/research/researchreports/reports/2015/CA16-2529_FinalReport.pdf

In-vehicle system displays the target speed because there is no interference from a preceding vehicle.

In-vehicle system does not provide a speed advisory because of a preceding vehicle.

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Caltrans Division of Research, Innovation and System Information

Research Results

Balancing Metered Onramp Queue Storage Space and Acceleration Distance

New design standards for metered onramps alleviate congestion and improve safety

Transportation Safety and Mobility

JANUARY 2017

Project Title:
Queue Storage and Acceleration Lane Length Design at Metered On-ramps in California

Task Number: 2449

Start Date: April 3, 2013

Completion Date: October 31, 2015

Product Category: New or improved manual, handbook, guidelines or training

Task Manager:
Jose Perez
Transportation Engineer
jose.perez@dot.ca.gov

WHAT IS THE NEED?

Onramp metering alleviates congestion by controlling the number of vehicles entering a freeway so that traffic demand does not exceed the freeway capacity. Metering also breaks up vehicle platoons, promoting smoother and safer merging by allowing only one car at a time to enter the flow of traffic. A Minnesota study showed that when ramp meters were turned off, throughput decreased by 9%, speeds dropped by 7%, travel time increased by 22%, and 26% more collisions occurred. Similarly, studies conducted in the San Francisco Bay Area indicated that metering reduced travel time by 30% along an 18-mile stretch of Route 580.

When designing and operating a metered onramp, properly locating the signal to provide adequate space for both waiting and accelerating vehicles is challenging, especially because metering locations are often existing ramps that have been retrofitted. When queue storage space is insufficient, vehicles spill over to the upstream arterial signals and impact the flow of surface streets. On the other hand, vehicles need adequate length to accelerate to a safe speed to join the mainline traffic. Across California, most freeway onramps at urban interchanges are either metered or proposed to be metered. Yet the Caltrans Highway Design Manual does not contain queue storage standards, and the standards for acceleration lane length are not always sufficient, particularly for buses and trucks.

Typical camera layout for queue storage data collection

WHAT WAS OUR GOAL?

The goal was to develop standards for designing queue storage and acceleration lane lengths for new and reconstructed metered onramps to include in the Caltrans Ramp Metering Design Manual and Highway Design Manual.

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Balancing Metered Onramp Queue Storage Space and Acceleration Distance

WHAT DID WE DO?

Caltrans, in partnership with the University of Nevada Center for Advanced Transportation Education and Research, began by identifying the factors that affect queue storage and acceleration at metered onramps. The researchers collected data at various locations, taking different metering methods and demand levels into account. Based on the field observations and modeling, they developed standards for estimating queue storage length and acceleration length for new and reconstructed interchanges, considering different types of arrival, metering methods, and demand levels.

WHAT WAS THE OUTCOME?

The research found that queue storage is mainly affected by onramp demand, vehicle platoons released from the upstream intersection, and the metering rate. Other influencing factors include upstream signal timing, lane usage, right-turn-on-red vehicles, and violation of ramp metering rules. An accurate description of the onramp flow arrival profile helps capture the real-time queuing process and improve queue length modeling results. A dual-level acceleration design standard was recommended to accommodate the unique operational features of the metered onramp, using a more aggressive design for existing onramps that have insufficient space or recurrent queue spillovers, which is about 35% shorter than the AASHTO Green Book acceleration length guideline. The conservative design standard is 10% shorter than the Green Book, but the recommended acceleration length for trucks is 60% greater.

Hook ramp with two feeding movements

Outer diagonal ramp with two feeding movements

WHAT IS THE BENEFIT?

Onramp metering is an effective strategy for traffic management, but the effectiveness is diminished if adequate space is not provided for waiting vehicles and acceleration. The new standards help eliminate or reduce onramp queue overspill onto local streets, which causes congestion, and specify adequate acceleration lane lengths so that vehicles can safely merge into mainline traffic and minimize potential collisions. Determining adequate queue storage length and the corresponding acceleration length is necessary for optimally designing and operating ramp meters to improve safety, reduce congestion, and reduce vehicle emissions.

LEARN MORE

To view the complete report:
www.dot.ca.gov/newtech/researchreports/reports/2016/CA16-2449_FinalReport.pdf

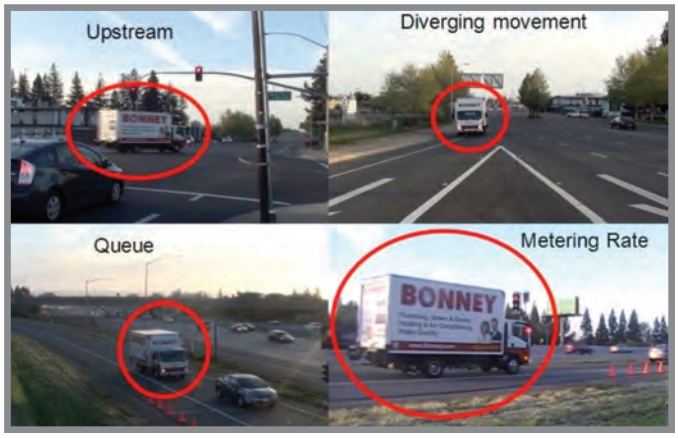

Illustration of video synchronization

DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

Pooling Truck Chassis to Economize Goods Movement from Ports

New chassis management strategies can make moving freight from ports more efficient

Transportation Safety and Mobility

MARCH 2017

Project Title:
Mitigating Urban Freight Through Effective Management of Truck Chassis

Task Number: 2813

Start Date: August 25, 2014

Completion Date: December 31, 2015

Product Category: New or improved business practice, procedure, or process

Task Manager:
Matt Hanson
Transportation Engineer
matt.hanson@dot.ca.gov

WHAT WAS THE NEED?

After a cargo ship unloads containers at a port, it is up to trucks to move them to the next destination. Intermodal chassis facilitate the easy transfer of shipping containers between ports, rail yards, distribution centers, and stores. Unlike ocean carriers in other parts of the world, including Canada, shipping lines operating in the United States usually own the chassis and provide it to truckers to transfer containers from the port to a local distribution facility. Truckers are then required to return the empty chassis to the terminal, adding time and expense to the process.

Shipping companies have come to realize that the current model is not sustainable. Each chassis costs about $8,000 and needs space to be stored when not in use. With a large number of expensive idle assets, shippers are looking to pass along costs or simply get out of the chassis business. As a result, companies are assessing various shared-management strategies, including pooling equipment with other carriers and permitting truckers to use the chassis for multiple trips. While these changes are being driven by the industry, the responsibility for providing facilities to manage pooled equipment falls into a jurisdictional "no man's land." Chassis management changes, such as the increased use of company chassis pools, third-party equipment leasing, and direct provisioning by truckers, have land-use implications both at terminal facilities and outside the port gates.

WHAT WAS OUR GOAL?

The goal was to assess the challenges and impacts of pooling truck chassis at Southern California ports in terms of land use and availability, freight flows, and traffic management.

Pooling intermodal container chassis can make goods movement more efficient but presents land-use challenges.

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Pooling Truck Chassis to Economize Goods Movement from Ports

WHAT DID WE DO?

Caltrans, in partnership with the METRANS Transportation Center, evaluated recent industry experiences with equipment divestiture, increased trade volumes, and the impact of these changes on the regional supply chains. Researchers at California State University, Long Beach surveyed a variety of stakeholders, including truckers, terminal operators, port management, rail companies, and chassis pool operators, to understand the incentives for them to take part in shared equipment management strategies. The researchers assessed the development of a pooled chassis strategy for the ports of Los Angeles and Long Beach and its implications for urban and regional freight mobility. They also identified the need for multi-sectorial, multi-jurisdictional, and public-private coordination.

WHAT WAS THE OUTCOME?

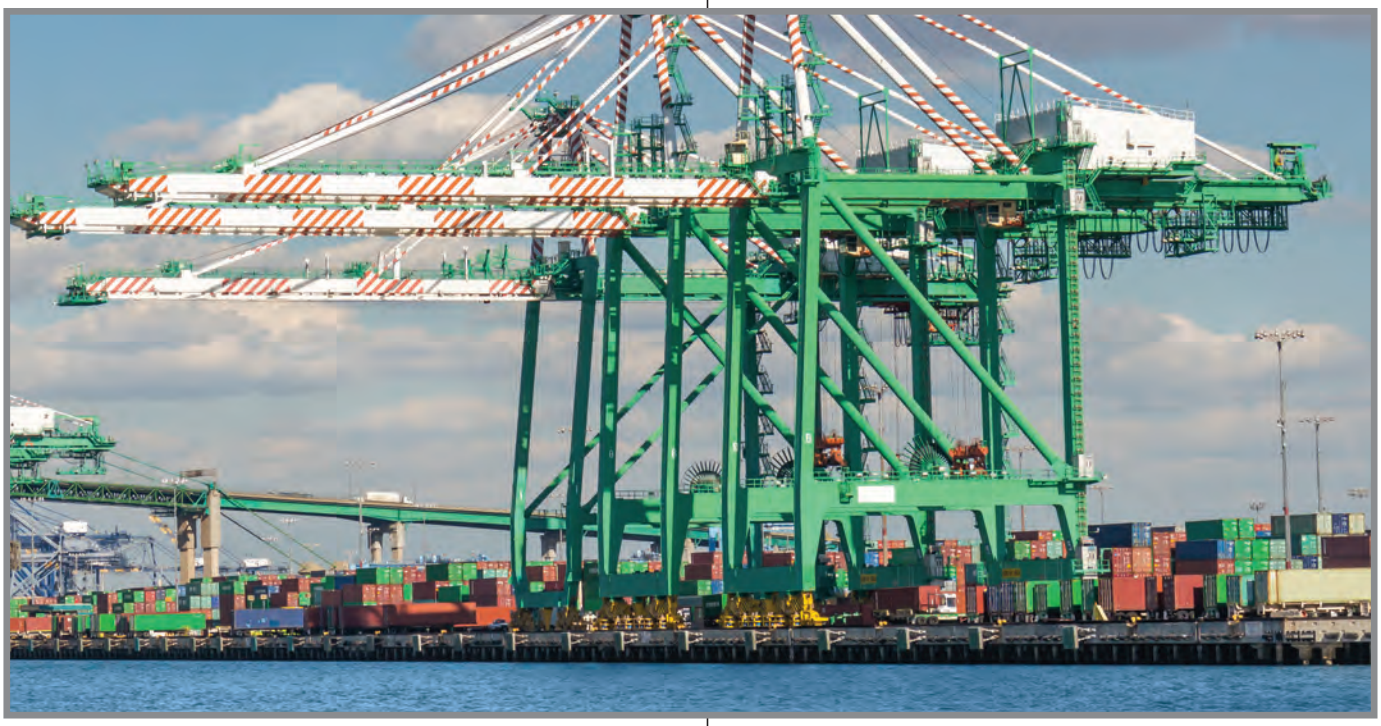
Although the pooled chassis management model is more efficient than earlier models, in Southern California, the current strategy might be an interim solution in response to short-term needs. For the labor sector, the issue of who controls the maintenance and repair of chassis leaving the terminals needs to be solved to determine the strategy's long-term viability. For planners, the shift to third-party providers could create a need for new and expanded chassis storage facilities near the ports and rail yards and at inland locations near distribution centers and warehouses. These changes can affect intra-metropolitan freight flows, creating demand for new access roads, particularly in the vicinity of ports.

WHAT IS THE BENEFIT?

The freight sector is a major contributor to California's economy with its own distinct mobility challenges. The strategy of pooling truck chassis as an interim approach to address more efficient goods movement reduces the number of chassis repositioning trips that trucks make to the terminals as well as the total trip time, thereby decreasing freight costs. Fewer truck movements means less commercial vehicle miles traveled and emissions throughout the region, although truck traffic in the vicinity of the ports could increase as trucks and chassis move between pool participants.

LEARN MORE

To view the complete report:
www.metrans.org/sites/default/files/research-project/2-2%20Chassis-OBrien%20final.pdf



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Research Results

New Control Strategies for Signalized Intersections

High-resolution data provides needed information at signalized intersections to support integrated corridor management and improve traffic flow

Transportation Safety and Mobility

MARCH 2017

Project Title:
Control Strategies for Corridor Management

Task Number: 2810 and 2818

Start Date: March 18, 2015

Completion Date: February 29, 2016

Product Category: New or improved decision support tool, simulation, model, or algorithm

Task Manager:
Jose Perez
Transportation Engineer
jose.perez@dot.ca.gov

WHAT WAS THE NEED?

Spatial constraints, limited funding, and environmental concerns have prompted new strategies for optimizing California's transportation network to maximize the flow of vehicles, people, and goods rather than adding more lanes and highways. Advancements in traffic sensing and control technology, from loop detectors, traffic cameras, and mobile phones to electronic road signs and personalized navigation devices, are facilitating dynamic traffic control. The concept of integrated corridor management (ICM) investigates how the various components of a transportation corridor—freeways, adjacent arterial streets, and transit lines—can work together as a cohesive, integrated system by using advanced technologies and system coordination to achieve a more efficient transportation system. Controlling traffic using adaptive signaling and dynamic ramp metering can help maximize throughput, reduce bottlenecks, and make transit lines more efficient, but detailed information on traffic conditions on arterial streets is needed to assess around-the-clock performance. New high-resolution (HR) data consisting of time-stamped records of every vehicle event at a signalized intersection is now available, providing opportunities for assessing existing traffic conditions and developing new control strategies.

WHAT WAS OUR GOAL?

The goal was to develop new traffic control strategies to maximize the flow of vehicles, people, and goods using real-time data acquired from signalized intersections.

Instrumented intersection in Danville, Calif.

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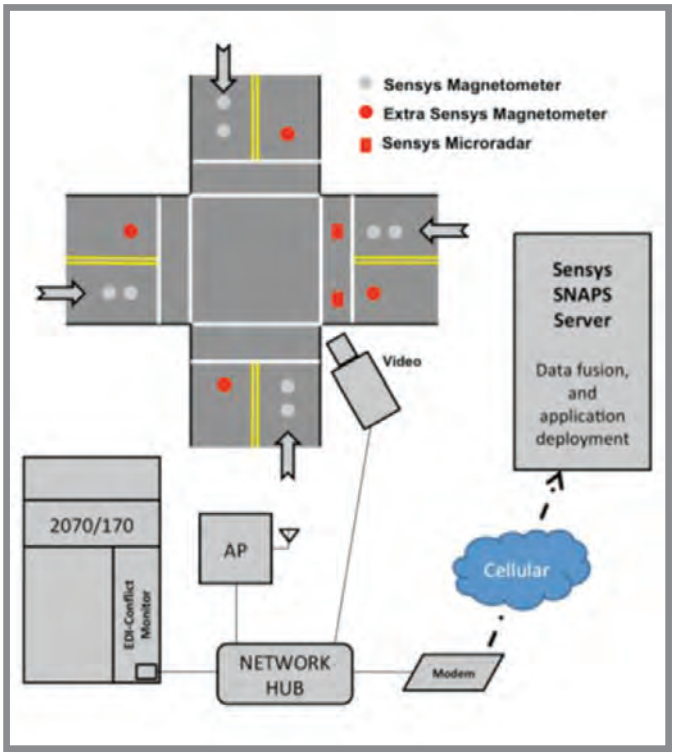
WHAT DID WE DO?

Caltrans, in partnership with the University of California Center on Economic Competitiveness in Transportation (UCCONNECT), analyzed real-time HR data collected from three multilane, multiphased signalized intersections covering a wide range of operating conditions to calculate performance measures and develop strategies for adjusting signal settings to optimize traffic flow and avoid or minimize queue overflow at intersections adjacent to metered freeway onramps by overriding ramp metering rates. The UC Berkeley researchers assessed the strategy with a traffic simulation model on a section of the I-680 freeway in the San Francisco Bay Area. They also developed a methodology to provide estimates on the impact of diverting freeway traffic for both recurrent and incident-related congestion.

In addition, Caltrans contracted the Metropolitan Transportation Center (METRANS), where University of Southern California researchers developed a dynamic traffic assignment framework that analyzes traffic flow over integrated freeway and arterial road networks to support adaptive traffic signaling and ramp metering methods to optimize system efficiency and resiliency during an incident.



Detectors capture data in real time at signalized intersections and transmit the information to servers.

WHAT WAS THE OUTCOME?

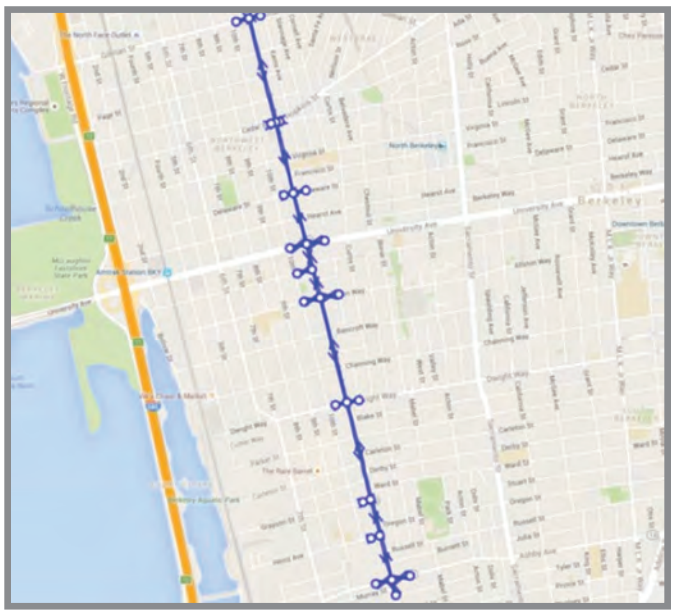
The new time-of-day adaptive signal controls, based on measured demand, outperformed conventional time-of-day plans that use predetermined time periods. The test results of the traffic control algorithms indicated that they were effective in eliminating queue override with significant freeway benefits to the onramp traffic. The framework developed supports the adoption of ICM strategies by providing a means to analyze freeway volumes and performance and divert traffic to adjacent arterials to relieve congestion due to an incident.

WHAT IS THE BENEFIT?

New adaptive control strategies at signalized intersections along arterials can reduce unnecessary delays and stops at traffic signals, queues to metered freeway onramps, and fuel consumption and emissions. Understanding dynamic traffic flow enables engineers to make signal adjustments in real time throughout the corridor that increase efficiency and resiliency of the existing traffic network and provide drivers advance notification to make alternative travel choices when traffic flow is compromised.

LEARN MORE

To view the report:
www.ucconnect.berkeley.edu/sites/default/files/65A0329FY14-15.QR4_AS.pdf



Signalized intersections along the San Pablo Avenue test arterial in Berkeley, Calif.

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Research Results

How Roadway Dynamics Affect Bicycle Crash Risk

New bicycle volume data helps planners distinguish between high-risk and low-risk locations to improve safety

Transportation Safety and Mobility

MAY 2017

Project Title:
Bicycle Crash Risk: How Does It Vary and Why?

Task Number: 2801

Start Date: May 15, 2015

Completion Date: March 31, 2016

Product Category: New or improved decision support tool, simulation, model, or algorithm

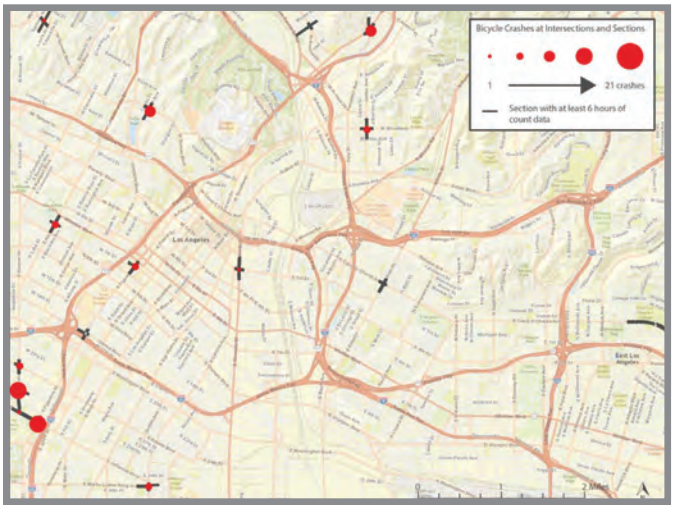
Task Manager:
Nathan Loebs
Transportation Engineer, Electrical
nathan.loebs@dot.ca.gov

WHAT WAS THE NEED?

Since 2006, bicyclist fatalities have increased, counter to the trend of decreasing automobile incidents. Why bicycle crashes constitute a disproportionate share of injuries and fatalities has been poorly understood due to a lack of exposure data, such as how many trips bicyclists are making and the number of bicyclists passing through a location over a period of time. Using only crash data does not provide the context needed for determining crash data trends. If bicyclist fatalities increased from one year to the next, does that indicate that streets have became less safe or does it mean that more bicyclists were on the road while the risk of crashes remained the same? According to the U.S. Census American Community Survey, bicycle ridership across California has nearly doubled between 2005 and 2014, yet fatalities have not risen proportionately. Information about bicycle crashes is accessible via the Statewide Integrated Traffic Records System (SWITRS), but until recently, corresponding exposure data was not available, making the crash rate unknown. In the past few years, more local agencies are conducting bicycle counts in a greater number of locations. With this new data, it is now possible to examine crash history while accounting for spatial variation in bicycle usage.

WHAT WAS OUR GOAL?

The goal was to model bicycle crash risk as a function of roadway design and operational characteristics by examining crash incidences together with ridership volume.



Number of crashes at select sections in downtown Los Angeles

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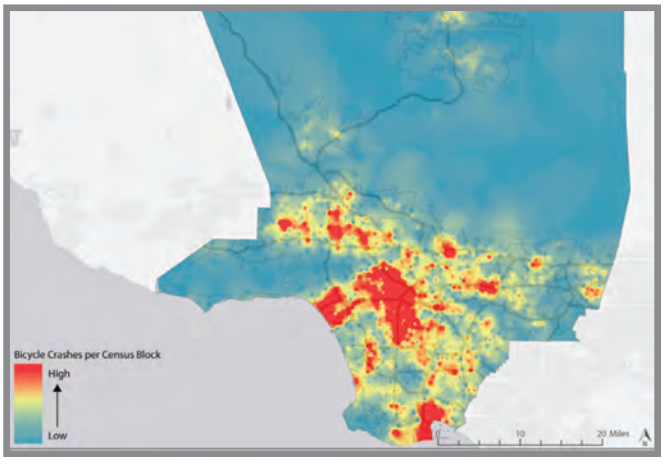
How Roadway Dynamics Affect Bicycle Crash Risk

WHAT DID WE DO?

Caltrans, in partnership with the University of California Center on Economic Competitiveness in Transportation (UCCONNECT), analyzed 247 intersections and 816 roadway segments in Los Angeles County to investigate the association between the number of crashes at a location and the number of bicyclists passing through the location over a period of time. UCLA researchers used the SWITRS crash incidence data and calculated bicycle exposure based on data from the Los Angeles County Bike Count Data Clearinghouse and other surveys. They also analyzed various roadway design and operational characteristics, adjacent land uses, and socioeconomic variables to examine correlations with crash risk.

WHAT WAS THE OUTCOME?

Many locations with high crash incidences also have high bicycle ridership. The locations with the highest crash risk tend to have below-average bicycle ridership. For some variables, a crash risk analysis reveals a different story than crash incidence alone would tell. For example, bikeways are associated with more crashes, but when ridership is taken into account, bikeways and non-bikeways have nearly identical crash risk. Prioritizing crashes as a metric can distract planners from identifying truly high-risk areas and direct funds and unneeded safety measures toward high ridership corridors where risk per cyclist is actually low. The results reinforce previous findings that bike lanes are an effective safety intervention and that a greater number of riders leads to cyclist safety.



Heat map of bicyclist-involved crashes resulting in injury in Los Angeles County, 2003–14 (Source: California Highway Patrol, SWITRS)

WHAT IS THE BENEFIT?

With bicycle infrastructure and bicycling activity on the rise, it is crucial to understand bicycle crash risk as a function of roadway design and operational characteristics as well as driver and bicyclist behavior. But crash risk cannot be estimated without bicycle count data to differentiate between high-incidence, high-risk sites and high-incidence, low-risk sites. This information helps transportation specialists design the appropriate safety countermeasures for the location.

LEARN MORE

To view the complete report:
www.its.ucla.edu/wp-content/uploads/sites/6/2016/08/Final-Report-to-Caltrans-Bicycle-Crash-v3.pdf

Crashes clustered using 50-foot buffers. The darker the green, the higher the number of crashes. The intersection was identified as a high-crash location.

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Research Results

Performance Metrics for Bicycle Infrastructure Investments

New demand and risk models help planners assess cycling infrastructure to encourage biking and make it safer

Transportation Safety and Mobility

MAY 2017

Project Title:
What Can a Bike Lane Do? Performance Metrics for Proposed Bicycle Infrastructure

Task Number: 2871

Start Date: April 20, 2015

Completion Date: May 31, 2016

Product Category: New or improved decision support tool, simulation, model, or algorithm

Task Manager:
Jerry Kwong
Transportation Engineer, Electrical
jerrykwong@dot.ca.gov

WHAT WAS THE NEED?

Over the past decade, bicycling has been steadily increasing. According to the American Community Survey, the number of bicycle commuters across California has nearly doubled between 2005 and 2014, from 108,800 to 207,100 riders. Unfortunately, over the same time period, the number of reported injury-related bicycle incidents increased from 10,560 to 12,965. Caltrans goal is to encourage bicycle use while decreasing the number of injuries. For transportation engineers, the main method to achieve this goal is by providing cycling infrastructure and other modifications to the built environment. When making decisions about construction, projected demand and expected reductions in crash risk are important factors to consider. However, making these investment decisions is difficult because the framework for forecasting the potential effects of infrastructure modifications on bicycle travel is not clearly defined. Metrics related to the environmental, economic, and health impacts for proposed bicycle infrastructure projects are needed.

WHAT WAS OUR GOAL?

The goal was to develop methods to assess the potential impacts of proposed bicycle infrastructure projects on multiple outcomes, including mode share and safety.

Buffered bicycle lane

Dashed green pavement markings indicate the lane is shared with cars

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Performance Metrics for Bicycle Infrastructure Investments

Research Results

WHAT DID WE DO?

Caltrans, in partnership with the University of California Center on Economic Competitiveness in Transportation (UCCONNECT), developed models to address knowledge gaps in the effects of bicycle infrastructure. The mode choice model evaluates the effects of myriad factors on an individual's decision to select a specific travel mode. The data fusion model incorporates various bicycle demand datasets, such as local transport and land-use characteristics, and yields network-wide bicycle volume estimates, a critical and frequently unavailable variable for crash prediction models. The UC Berkeley researchers used San Francisco as a case study to assess the models.

WHAT WAS THE OUTCOME?

The analytical methods include major advances in the state of bicycle demand modeling.

- A new way to account for spatial variables, such as bike facilities, speed limits, and slopes from the trip's origin to the destination, in mode choice models. Previous methods were computationally difficult and relied on extensive route choice data or considered only the surroundings of the origin and destination, not the characteristics between these points.
- Model improvements that account for "class imbalance"—a statistical problem that is encountered when the proportion of data points in one group, for example, people who choose to bike, is much smaller than other classes, such as people who choose to drive.
- A method for fusing bicycle demand datasets, including bicycle counts, travel-demand model estimates, crowd-sourced data, and bikeshare system data, to get link-level traffic volumes across an entire network. Planners can use the traffic volume estimates to evaluate the crash risk imposed by current facilities.

WHAT IS THE BENEFIT?

Biking can reduce vehicle miles traveled and alleviate congestion, but it requires investment in infrastructure to improve safety and efficiency. The new performance metrics enhance the ability to anticipate the effects of new bike facilities and broaden the factors to consider when investing in biking infrastructure. Planners can better anticipate the effects of bike lane construction on individuals' decisions to bicycle and understand the relationship between infrastructure features and crash risk.

LEARN MORE

Report forthcoming.

Appendix 1: Caltrans Membership on TRB Committees

The Transportation Research Board (TRB) promotes innovation and progress in transportation through research. TRB is one of seven program units of the National Academies of Sciences, Engineering, and Medicine, which provides independent, objective analysis and advice to the nation and conducts other activities to solve complex problems and inform public-policy decisions. The program is supported by state transportation departments, federal agencies, including the component administrations of the U.S. DOT, and other organizations and individuals interested in the development of transportation. As of January 2016, Caltrans staff served on the following TRB committees.

Committee Member	Committee Name
Malcolm Dougherty	Executive Committee
Coco Briseno	Task Force on Data for Decisions and Performance Measures
Michelle Tucker	Task Force on Knowledge Management
Marc Birnbaum	Standing Committee on Access Management
Michael Johnson	Standing Committee on Bridge Management
Michael Johnson	Standing Committee on Bridge Preservation
Hamid Sadraie	Standing Committee on Characteristics of Asphalt Paving Mixtures to Meet Structural Requirements
Coco Briseno	Standing Committee on Conduct of Research
Herby Lissade	Standing Committee on Critical Transportation Infrastructure Protection
Joann Georgallis	Standing Committee on Eminent Domain and Land Use
Joseph Peterson	Standing Committee on Flexible Pavement Construction and Rehabilitation
Sharid Amiri	Standing Committee on Foundations of Bridges and Other Structures
Ali Zaghari	Standing Committee on Freeway Operations
Douglas MacIvor	Standing Committee on Freight Transportation Data
Diane Jacobs	Standing Committee on Freight Transportation Planning and Logistics
Nicholas Burmas	Standing Committee on Full-Scale Accelerated Pavement Testing
Susan Hida	Standing Committee on General Structures
Chad Baker	Standing Committee on Geographic Information Science and Applications
Zhongren Wang	Standing Committee on Geometric Design
Anoosh Shamsabadi	Standing Committee on Geotechnical Instrumentation and Modeling
Anmarie Medin	Standing Committee on Historic and Archeological Preservation in Transportation
Greg Larson	Standing Committee on Intelligent Transportation Systems
Zhongren Wang	Standing Committee on International Cooperation
Keith Robinson	Standing Committee on Landscape and Environmental Design
Lisa Kunzman	Standing Committee on Maintenance Equipment
Joseph Rouse	Standing Committee on Managed Lanes
Stanton Hunter	Standing Committee on Passenger Rail Equipment and Systems Integration
Zhongren Wang	Standing Committee on Pavement Management Systems
Dulce Feldman	Standing Committee on Pavement Monitoring and Evaluation
Hamid Sadraie	Standing Committee on Pavement Monitoring and Evaluation

Committee Member	Committee Name
Robert Hogan	Standing Committee on Pavement Rehabilitation
Dulce Feldman	Standing Committee on Portland Cement Concrete Pavement Construction
Erik Alm	Standing Committee on Regional Transportation Systems Management and Operations
Dulce Feldman	Standing Committee on Rigid Pavement Design
Jerome Champa	Standing Committee on Roundabouts
Thomas Ostrom	Standing Committee on Seismic Design and Performance of Bridges
Chris Risden	Standing Committee on Soil and Rock Properties
Katie Benouar	Standing Committee on Statewide Multimodal Transportation Planning
Coco Briseno	Standing Committee on Statewide Transportation Data and Information Systems
Ramamohan Bommavaram	Standing Committee on Strategic Management
Stephen Guenther	Standing Committee on Strategic Management
Hamid Sadraie	Standing Committee on Strength and Deformation Characteristics of Pavement Sections
Hamid Sadraie	Standing Committee on Subsurface Soil-Structure Interaction
Joseph Horton	Standing Committee on Technology Transfer
Herby Lissade	Standing Committee on the Logistics of Disaster Response and Business Continuity
Jeanne Scherer	Standing Committee on Tort Liability and Risk Management
Koohong Chung	Standing Committee on Traffic Flow Theory and Characteristics
Zhongren Wang	Standing Committee on Traffic Flow Theory and Characteristics
LaNae Van Valen	Standing Committee on Transportation Energy
Greg Larson	Standing Committee on Vehicle-Highway Automation
Joseph Horton	Standing Committee on Winter Maintenance
Theresa Drum	Standing Committee on Work Zone Traffic Control
Douglas MacIvor	Subcommittee on Statewide Travel Demand Forecasting
Charles Sikorsky	Long-Term Bridge Performance (LTBP) Committee: Expert Task Group for Bridge Evaluation and Monitoring
Susan Hida	Committee for Review of USDOT Truck Size and Weight Study
Herby Lissade	Committee on The Role of Freight Transportation in Economic Competitiveness: The 8th University Transportation Center Spotlight Conference
Kelly Lier	Ad Hoc Working Group on Commodity Flow Survey Workshop Planning Team

Appendix 2: Caltrans Membership on NCHRP Project Panels

Administered by TRB, the National Cooperative Highway Research Program (NCHRP) is a forum for coordinated and collaborative research that addresses issues integral to the state departments of transportation and transportation professionals at all levels of government and the private sector. The NCHRP provides practical, ready-to-implement solutions to pressing problems facing the industry. As of January 2016, Caltrans staff served on the following NCHRP project panels.

Panel Member	Project Title
William Owen	AASHTO Manual on Subsurface Investigations - Manual Update
Ken Solak	AASHTO Partnering Handbook, Second Edition
Brian Syftestad	Alternate Bidding of Pipe Materials
Jon Tapping	Alternative Quality Systems for Application in Highway Construction
Marco Ruano	Analysis of Oversaturated Traffic Flow Conditions and Managed Lanes on Freeway Facilities
Van Her	Application of MASH Test Criteria to Breakaway Sign and Luminaire Supports and Crashworthy Work Zone Traffic Control Devices
Troy Tusup	Applying Risk Analysis, Value Engineering, and other Innovative Solutions for Project Delivery
Dale Widner	Assessment of Geometric Design Policies and Processes
Charles Fielder	Best Practices on Accelerating Project Delivery: Conception to Completion
Susan Hida	Bridge System Reliability for Redundancy
Herby Lissade	Catastrophic Transportation Emergency Management Guidebook
Kevin Flora	Combining Individual Scour Components to Determine Total Scour
Steve Takigawa	Convincing the Stakeholders: Developing a Guide for Communicating Maintenance and Preservation Needs
Dana Hendrix	Costing Asset Protection: An All-Hazards Guide for Transportation Agencies (CAPTA) - Update and Implementation
Greg Larson	Costs and Benefits of Public-Sector IntellDrive Deployment
Rachel Falsetti	Costs of Alternative Finance Systems
Jim De Luca	Crossing Treatments at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities
Parviz Lashai	Culvert and Storm Drain Inspection Manual
Zhongren Wang	Design Guidance for Interchange Loop Ramps
Jim Gutierrez	Design Guidelines for Field Deployment of CFRP Prestressed Beams in Bridge Construction
John Rogers	Detection and Remediation of Soluble Salt Contamination Prior to Coating Steel Highway Structure
Herby Lissade	Developing a Consistent Coding and Training System for Emergency Structure Inspections
Jesus Mora	Developing Guidelines for GPS (Geographical Positioning System) Controlled Construction Machine Guidance and Required CADD Software
Bruce Rymer	Developing Precision and Bias Statements for AASHTO Standard Methods of Test TP 98 and TP 99
Marc Birnbaum	Development and Application of Access Management Guidelines
Mohamed AlKadri	Development of a Guide for Transportation Technology Transfer
Jeanne Scherer	Development of a Strategic National Highway Infrastructure Safety Research Agenda
Coco Briseno	Development of a Transportation Asset Management Gap Analysis Tool to Complement the AASHTO TAM Implementation Guide
Amir Malek	Development of Bridge Foundation Movement Criteria

Panel Member	Project Title
Karen Jewel	Development of Cost-Effective Treatments of Roadside Ditches to Reduce the Number and Severity of Roadside Crashes
Brian Alconcel	Development of Crash Reduction Factors for Uncontrolled Pedestrian Crossing Treatments
Troy Arseneau	Development of Guidelines for the Use of Simulation and Other Models in Highway Capacity Analyses
Barry Padilla	Economic Productivity and Transportation Investment Priorities
Marlon Flournoy	Effective Project Scoping Practices to Improve On-Time and On-Budget Delivery of Highway Projects
Cathrina Barros	Engineering Properties/Field Performance of Warm Mix Asphalt Technologies
Joanne McDermott	Enhanced Truck Data Collection and Analysis for Emissions Modeling
Chris Schmidt	Environmental Justice Analyses When Considering Toll Implementation or Rate Changes
Chris Schmidt	Estimating Bicycling and Walking for Planning and Project Development
Steve Guenther	Estimating the Return on Investment in Transportation Asset Management Systems and Practices
Robert Peterson	Evaluation of Opposite Direction Crashes and Appropriate Countermeasures
Keith Robinson	Evaluation of the Methodologies for Visual Impact Assessments
Kee Foo	Field versus Laboratory Volumetrics and Mechanical Properties
Vahid Nowshiravan	Finding and Using Data to Identify and Evaluate Corridors for Transporting Multi-state, Multi-modal Oversize/Overweight Freight
Herby Lissade	FloodCast: A Framework for Enhanced Flood Event Decision Making for Transportation Resilience
Lian Duan	Fracture-Critical System Analysis for Steel Bridges
Loren Turner	Guidance for Development and Management of Sustainable Information Portals
Agustin Rosales	Guidance for the Management of Traffic and Safety Assets
Glenn DeCou	Guidance to Predict and Mitigate Dynamic Hydroplaning on Roadways
Michael Keever	Guide for Proposed AASHTO Seismic Specifications for ABC Column Connections
Lisa Kunzman	Guide for Utilization Measurement and Management of Fleet Equipment
Raymond Tritt	Guidebook for Construction Manager-at-Risk Contracting for Highway Projects
Michelle Tucker	Guidebook on Agency Risk Management Strategies, Methods, and Tools
Joseph Dongo	Guidelines for Managing Geotechnical Risks in Design-Build Projects
Kristina Assouri	Guidelines for Managing Geotechnical Risks in Design-Build Projects
Louis Betancourt	Guidelines for Selecting Ramp Design Speeds
Charles Fielder	Guidelines to Incorporate the Costs and Benefits of Adaptation Measures in Preparation for Extreme Weather Events and Climate Change
William Farnbach	Handbook for Pavement Design, Construction, and Management
Kenneth Brown	Highway Bridge Fire Hazard Assessment
Zhongren Wang	Horizontal Sightline Offset Design Criteria, Exceptions, and Mitigation Strategies
Greg Larson	Impacts of Connected and Automated Vehicles on State and Local Transportation Agencies
Prakash Sah	Impacts of Transit System Regulations and Policies on CV/AV Technology Introduction
Coco Briseno	Improving Access to Transportation Information
Chad Baker	Improving Findability and Relevance in Transportation Information
Imad Basheer	Incorporating Pavement Preservation Into the MEPDG

Panel Member	Project Title
Joanne McDermott	Integrating Goods and Services Movement Commercial Vehicles in Smart Growth Environments
Lawrence Orcutt	Intellectual Property Stewardship Guide for Transportation Departments
Douglas MacIvor	Long Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models
Karla Sutliff	Low-Cost Improvements for Recurring Freeway Bottlenecks
Keith Robinson	Managing Rights-of-Way for Biomass Generation and/or Carbon Sequestration
Bruce Rymer	Mapping Noise Source Heights for Highway Noise and Barrier Analysis
Wilfung Martono	Mechanistic-Empirical Model for Top-Down Cracking of Asphalt Pavement Layers
Bruce Rymer	Meteorological Effects on Roadway Noise
Bruce Rymer	Methodologies for Evaluating Pavement Strategies and Barriers for Noise Mitigation
Barry Padilla	Methodology for Estimating the Value of Travel Time Reliability for Truck Freight System Users
Don Nguyen-Tan	Minimum Flexural Reinforcement Laboratory Testing
Dulce Feldman	Model for Incorporating Slab/Underlying Layer Interaction into the MEPDG Concrete Pavement Analysis Procedures
David Gamboa	Modifications to HCM Signal Analysis to Support Reliability Assessment and Maintenance of Signal Timing
Roberto Buendia	Next Generation of the FHWA Transportation Pooled Fund (TPF) Website
Raymond Tritt	Optimum Life-Cycle Analysis of Maintainable Assets
Lawrence Orcutt	Performance Measurement Tool Box and Reporting System for Research Programs and Projects
Nicholas Burmas	Performance Related Specifications (PRS) for Pavement Preservation Treatments
Kee Foo	Performance-Related Specifications for Asphaltic Binders Used in Preservation Surface Treatments
Paul Cooley	Practical Bridge Preservation Actions and Investment Strategies
Joanne McDermott	Prioritization Procedure for Proposed Road-Rail Grade Separation Projects along Specific Rail Corridor
Kevin Flora	Procedure for Determination of the Joint Probability of Design Peak Flows at Confluences
Medhi Parvini	Proposed Enhancements to Pavement ME Design: Improved Consideration of the Influence of Subgrade and Unbound Layers on Pavement Performance
Alan Torres	Proposed Revisions to the AASHTO Movable Bridge Inspection, Evaluation and Maintenance Manual, 1st Edition, 1998
Rene Garcia	Protection of Transportation Infrastructure from Cyber Attacks
Dorie Mellon	Recommended Guidelines for Prefabricated Bridge Elements and Systems Tolerances and Dynamic Effects of Bridge Moves
Hamid Sadraie	Relating Asphalt Binder Fatigue Properties to Asphalt Mixture Fatigue Performance
Steve Ng	Risk-Based Approach for Bridge Scour Prediction
Charles Ineichen	Scour at the Base of Retaining Walls and Other Longitudinal Structures
Hernan Perez	Seismic Design of Geosynthetic-Reinforced Soil (GRS) Bridge Abutments with Flexible Facing
Madhwesh Raghavendrachar	Self-Consolidating Concrete for Cast-in-Place Bridge Components
Cathrina Barros	Short-Term Laboratory Conditioning of Asphalt Mixtures
Marc Birnbaum	Strategies to Reduce Agency Costs and Improve Benefits Related to Highway Access Management
Mark Weaver	Streamline and Simplify Right-of-Way Procedures and Business Practice
James Elder	Streamlining Project Level Air Quality Analysis through Development of New Tools/Interfaces

Panel Member	Project Title
Amir Malek	Structural Testing and Design Methodology for Single Column-Single Shaft Foundation Considering the Flexural Capacity of Steel Casing
Herby Lissade	Surface Transportation Security Research
Herby Lissade	Synthesis of Airport Closings and Emergency Evacuation Problems
Diana Gomez	Transportation Guide for All-Hazards Emergency Evacuation
Bljan Sartipi	Travel Demand Forecasting: Parameters and Techniques
Marc Birnbaum	Update of the TRB Access Management Manual
Roberta McLaughlin	Update Section 2B.07 of MUTCD-Multi-way Stop Control (Unsignalized Intersection Control Warrants/Criteria)
Dale Widner	Update to TRB Special Report 214: Designing Safer Roads--Practices for Resurfacing, Restoration and Rehabilitation
Theresa Drum	Work Zone Crash Characteristics and Countermeasure Guidance

Appendix 3: Caltrans Membership on NCFRP Project Panels

Administered by TRB, the National Cooperative Freight Research Program (NCFRP) conducts research and disseminates timely findings that inform investment and operations decisions affecting the performance of the freight transportation system. As of January 2016, Caltrans staff served on the following NCFRP project panels.

Panel Member	Project Title
Douglas MacIvor	Capacity and Level of Service Analysis for Trucks
Diane Jacobs	Creating Publicly Available Measures of Freight Trucking Activity
Douglas MacIvor	Estimating Freight Generation Using Commodity Flow Survey Microdata
Diane Jacobs	Evaluating Alternatives for Landside Transport of Ocean Containers
Douglas MacIvor	Factors Influencing Freight Modal Shift
Douglas MacIvor	Freight Trip Generation and Land Use (Jointly Funded as NCHRP B8-80)
Diane Jacobs	Guidebook for Developing Sub-national Commodity Flow Data
Douglas MacIvor	Impact of Smart Growth on Metropolitan Goods Movement
Chad Baker	Improving Freight System Performance in Metropolitan Areas
Douglas MacIvor	Strategies for Measuring the Costs of Freight Transportation
Chad Baker	Web-Based Simulation Tool for Shared-Use Rail Corridor

Appendix 4: Caltrans Membership on ACRP Project Panels

Administered by TRB, the Airport Cooperative Research Program (ACRP) is an industry-driven, applied research program that develops near-term, practical solutions to problems faced by airport operators. As of January 2016, Caltrans staff served on the following ACRP project panels.

Panel Member	Project Title
Philip Crimmins	Assessing Aircraft Noise Conditions Affecting Student Learning-Case Studies
Philip Crimmins	Guidebook of Practices for Improving Environmental Performance at Small Airports
Gary Cathey	Synthesis of Information Related to Airport Problems

Appendix 5: Caltrans Membership on TCRP Project Panels

Administered by TRB, the Transit Cooperative Research Program (TCRP) is an applied, contract research program that develops near-term, practical solutions to problems facing transit agencies. Caltrans staff who served in FY 2014/15 on the following TCRP project panels.

Panel Member	Project Title
Rene Garcia	Command-Level Decision Making for Transit Emergency Managers

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