Caltrans

DRISI

Caltrans Division of Research,
Innovation and System Information

Fiscal Year 2013/14 Annual Research Program Highlights

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Caltrans Research Program

Fiscal Year 2013/14

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

In fiscal year 2013/14, our Executive Board reviewed Caltrans' role in supporting California's transportation needs and concluded that the Caltrans mission, vision, and goals needed to be updated to ensure that Caltrans is well prepared for the future. To better articulate what kind of transportation system and leadership California needs going forward, our Executive Board devoted thought and discussion to determine why Caltrans exists as an organization, what we want to accomplish, and what will define our success.

This interchange resulted in a new mission, vision, and goals to transform Caltrans into a revitalized, sustainable, and streamlined organization to fulfill our job of getting people from point A to point B while improving our state's safety, economy, and environment.

Caltrans Mission

Provide a safe, sustainable, integrated, and efficient transportation system to enhance California's economy and livability.

Caltrans Vision

A performance-driven, transparent, and accountable organization that values its people, resources, and partners and meets new challenges through leadership, innovation, and teamwork.

Caltrans Goals

Safety and Health
Provide a safe transportation system for workers and users, and promote health through active transportation and reduced pollution in communities.

Stewardship and Efficiency
Money counts. Responsibly manage California's transportation-related assets.

Sustainability, Livability, and Economy
Make long-lasting, smart mobility decisions that improve the environment, support a vibrant economy, and build communities, not sprawl.

System Performance
Utilize leadership, collaboration, and strategic partnerships to develop an integrated transportation system that provides reliable and accessible mobility for travelers.

Organizational Excellence
Be a national leader in delivering quality service through excellent employee performance, public communication, and accountability.

Aligning DRISI's strategic plan with Caltrans' mission, vision, and goals

The Division of Research, Innovation and System Information (DRISI) launched FY 2013/14 by developing and adopting a three-year strategic plan to define our role in furthering Caltrans' new mission, vision, and goals. We adjusted our purpose and goals to better reflect the critical role that DRISI plays in advancing California's transportation system, developing comprehensive transportation solutions, and creating and disseminating transportation-related knowledge.

DRISI Purpose

Provide solutions and knowledge that improve California's transportation system.
This purpose better reflects the advantages and value DRISI offers.

DRISI Goals

Strengthen and sustain our ability to serve as a central resource for technical expertise.
DRISI's greatest asset is our staff. We will build and leverage our mission-critical skills and knowledge and organize staff and resources to deliver the highest quality transportation research and system information solutions to our customers.

Optimize the quality and value of our products and services.
We will strive to improve how we operate, including streamlining business processes, better engaging customers and partners, increasing data integrity, and supporting the implementation of our research products.

Catalyze organizational and transportation innovations.
This goal responds to our customers' call for DRISI to be Caltrans' go-to service division by providing the needed transportation research and system information for sparking innovation, supporting critical decision-making, and solving challenges.

Progressing with new purpose

Moving forward, DRISI will draw strength and support from our partners to better serve and engage our customers as we fulfill our purpose of providing innovative transportation solutions and knowledge.

I invite you to explore the following pages of this report to gain insight on our research program achievements in FY 2013/14.

Coco Briseno, Chief
Division of Research, Innovation and System Information

Division Accomplishments

FY 2013/14 proved to be a year of progress for DRISI. Some notable division accomplishments include implementation assistance awards, national recognition for our research, and strengthened partnerships.

Cultivating knowledge with national partners and programs

DRISI serves as the conduit for Caltrans to leverage national partnerships and resources to solve transportation challenges for California. For example, DRISI coordinates Caltrans' participation in the Strategic Highway Research Program 2 (SHRP 2), which is managed by the Federal Highway Administration (FHWA) in cooperation with the American Association of State Highway and Transportation Officials (AASHTO) and Transportation Research Board (TRB).

SHRP 2 developed more than 65 products and processes that can be used by transportation agencies to address key challenges in four focus areas: safety, renewal, reliability, and capacity. As of FY 2012/13, Caltrans received seven implementation assistance awards in the first four application rounds for the following products.

- **Implementing Eco-Logical**
  Better environmental and highway outcomes through integrated planning
- **Organizing for Reliability**
  Improving travel-time reliability through innovative operations and management
- **Innovative Bridge Designs for Rapid Renewal**
  Plans, designs, and concepts to build and replace bridges faster
- **Expediting Project Delivery**
  Strategies for addressing or avoiding common constraints to improve planning and environmental reviews
- **Railroad Agreements**
  Model agreements to improve coordination and cooperation at highway and railroad connections and junctions
- **Pavement Renewal Solutions**
  Design and construction guidelines for long-life pavements
- **Tools for Assessing Wider Economic Benefits of Transportation**
  Estimation methods that are more transparent and provide a more complete understanding of the economic impact of highway projects

Achieving the 2013 High Value Research Sweet 16 designation

In July 2013, the AASHTO's Research Advisory Committee selected DRISI's research project "Enhancing a Freeway Safety Performance Measurement Tool" as one of the 2013 High Value Research Sweet 16 projects that exemplify transportation excellence through research. The tool is a web-based application to evaluate and quantify freeway safety performance based on traffic patterns, roadway characteristics, and driver behavior parameters. The research characterized how these parameters combine to increase or decrease the risk of different types of traffic collisions.

Strengthening our partnership with University Transportation Centers

In September 2013, the Office of the Assistant Secretary for Research and Technology (formerly known as Research, Innovation and Technology Administration) of the U.S. Department of Transportation awarded California three new University Transportation Centers (UTC) during federal fiscal years 2013 and 2014.

- METRANS Transportation Center at the University of Southern California
- National Center for Sustainable Transportation (NCST) at the University of California, Davis
- University of California Center on Economic Competitiveness in Transportation (UCCONNECT) at the University of California, Berkeley

With the addition of these new UTCs, DRISI partnered with the UTC directors and Caltrans divisions and districts to develop a new collaborative process to:

- Identify and assess Caltrans' research needs
- Review and rank UTC research proposals
- Select and manage UTC research projects

The UTC project selection process cultivates accountability and transparency at all phases, from needs assessment to project selection. With the continued support from our dedicated UTC partners and Caltrans divisions and districts, we can ensure that high-priority research projects address California's transportation challenges.

Research Program Administration

The research program's two main funding sources are the federal State Planning and Research (SP&R) Part II 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 through dissemination, demonstration, training, and adoption. In FY 2013/14, DRISI managed a $24.3 million research program to deliver research results and products that addressed transportation challenges across California.

DRISI's primary source of federal funding is SP&R Part II administered by FHWA. SP&R Part II provided $12 million (49%) of DRISI's FY 2013/14 research program budget. DRISI allocated these monies to:

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

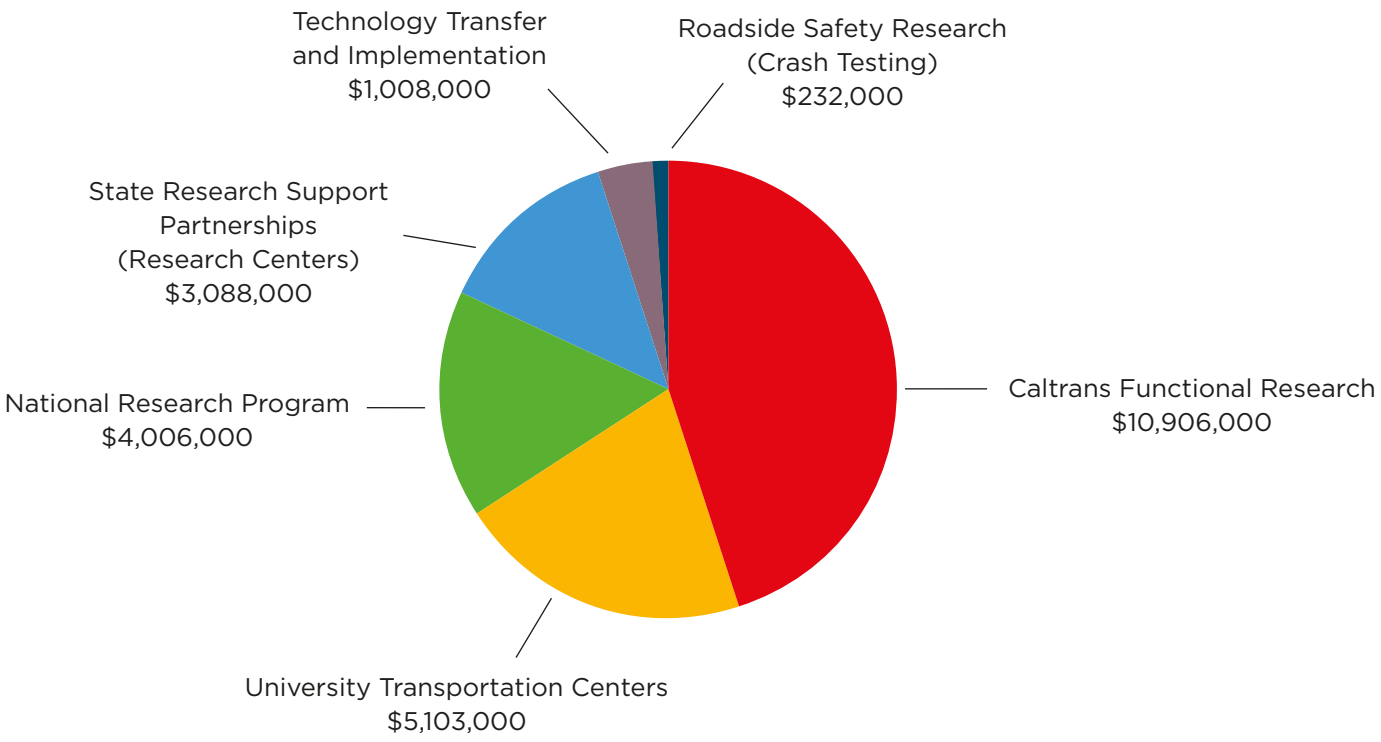
SHA is generated from the state excise tax on gasoline and diesel fuels and provided $12.3 million (51%) of the research program budget. SHA monies were used to:

- Provide match funding for federally funded research tasks
- Fund University Transportation Centers (UTCs)
- Support technology transfer and implementation of research results and products

DRISI funds a balanced, comprehensive research program to efficiently administer research tasks from idea to product for customers in Caltrans' programs and districts. DRISI allocates research funds in the following 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)

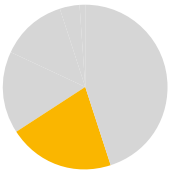
Allocation of FY 2013/14 Research Funds



FUNDING CATEGORIES

Caltrans Functional Research | $10,906,000

The DRISI research portfolio comprises Caltrans functional research and research delivered through UTCs. The tasks are selected through the process described on page 12 and are grouped by functional areas to align with Caltrans' core programs. In FY 2013/14, DRISI managed 186 research tasks covering various functional areas, of which 47 were completed. For a summary of all research tasks underway in FY 2013/14, see pages 20-27.



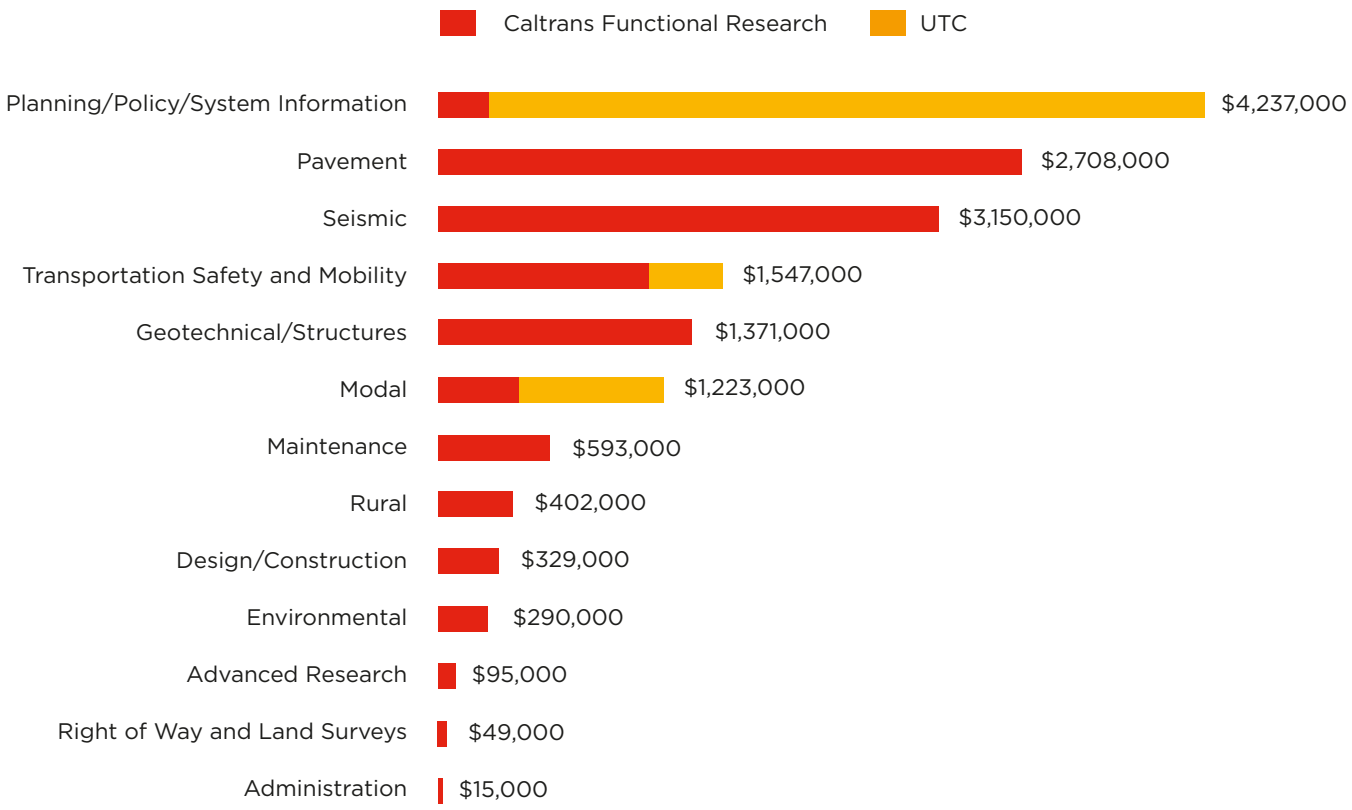
University Transportation Centers | $5,103,000

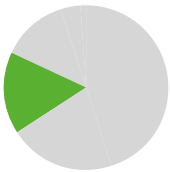
UTCs are internationally recognized centers of excellence that are fully integrated within institutions of higher learning. The UTC program is administered by the U.S. Department of Transportation (U.S. DOT). The UTC program's purpose is to advance transportation technology and expertise through research, education, and technology transfer; provide a critical transportation knowledge base outside of the U.S. DOT; and address the vital 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 2013/14, DRISI provided match funding for five UTCs. More information about these five UTCs is on pages 18-19:

- 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

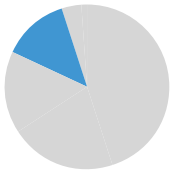
Distribution of Caltrans Functional Research and UTC Funds





National Research Program | $4,006,000

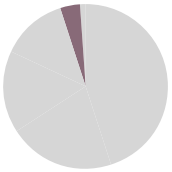
Caltrans partners with national transportation organizations, including the TRB and the National Cooperative Research Program (NCRP). Caltrans benefits from national research efforts through leveraging research conducted at the national level and by serving on committees and panels that identify critical transportation issues, recommend project selection, and guide implementation. More information about these national programs is on pages 13-15. In FY 2013/14, Caltrans staff actively participated on 97 highway, 7 freight, and 3 airport cooperative research project panels (see Appendices 1–3).



State Research Support Partnerships (Research Centers) | $3,088,000

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. More information about the following research centers is on pages 16-17:

- Advanced Highway Maintenance and Construction Technology
- Pacific Earthquake Engineering Research
- Partners for Advanced Transportation Technology
- University of California Pavement Research Center



Technology Transfer and Implementation | $1,008,000

Moving research results and products into Caltrans practice requires multichannel, sustained technology transfer and implementation efforts. DRISI uses various tools and methods to encourage the adoption of research results and products. These efforts include implementation plans and 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

In FY 2013/14, DRISI developed developed implementation plans to identify the challenges, opportunities, and strategies for the widespread adoption and integration of research products by Caltrans divisions and districts into their mainstream business practices.

DRISI uses a mix of outreach tools and methods to communicate research results and products. The outreach tools and methods include oral, electronic, and print communications.

Oral communication channels:

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

Electronic and print communication vehicles:

- **Annual Research Program Highlights report** showcases DRISI's activities and completed research over the past year.
  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** provide 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/newtech/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 Group (Crash Testing) | $232,000

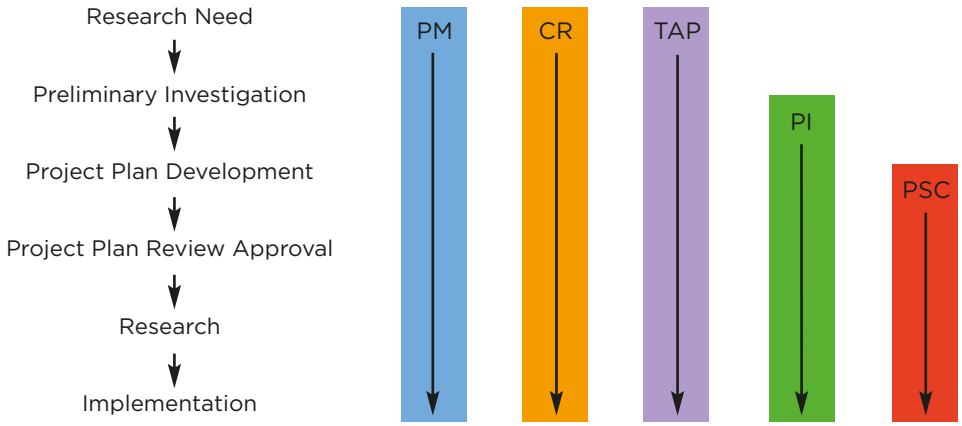
The roadside safety research group evaluates the crash worthiness of safety technology, such as barriers, guardrails, crash cushions, bridge rails, sign supports, and other hardware. They conduct full-scale crash tests on roadside safety hardware designs developed by Caltrans to ensure that these designs 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. In addition, 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 three levels of committees to aid in developing research needs, selecting research projects, and deploying and implementing research products. The Research and Deployment Advisory Committee (RDAC) recommends research priorities and funding allocations among the functional areas and actively sponsors the deployment and implementation of the resulting research products. The RDAC includes deputy district directors and the division chiefs, who are also the leads of the 10 program steering committees (PSC). The PSCs adopt an agenda for a multiyear integrated research program, develop program-level research priorities, and support the deployment and implementation of research products. Each PSC includes at least one technical advisory panel (TAP), which includes technical experts from the various divisions and districts. The TAP suggests, reviews, and ranks the problem statements and preliminary investigation requests.

In conjunction with other Caltrans divisions, DRISI project managers propose new research projects annually in January. The PSCs and DRISI management review the proposals in February. PSC leads prioritize their respective proposals in March, and the RDAC approves the annual portfolio in April.

Research Process and Roles



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

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

Technical Advisory Panel (TAP)
Each TAP has a vital role in reviewing problem statements, ranking preliminary investigations, recommending investigations, and providing recommendations for continuing and new projects.

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

Program Steering Committee (PSC)
Each PSC has a vital role in establishing new research projects. PSC membership consists of division chiefs, district representatives, and relevant external partners.

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 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.

TRB's core program budget was $16 million in 2013, with approximately 46% funded by the state departments of transportation. The remainder comes from federal agencies, other transportation organizations, and TRB self-generated revenue. With a contribution of $475,427 in 2013, Caltrans was able to leverage $34 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
- Transit Cooperative Research Program
- National Cooperative Freight Research Program
- Airport Cooperative Research Program
- Second Strategic Highway Research Program

In 2014, the National Cooperative Highway Research Program (NCHRP) selected 58 projects for funding, of which 26 were important to Caltrans, 15 were of significant interest, and 7 have Caltrans staff currently serving on the project panel. 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. California benefited from many cooperative research projects, two of which are featured below.

NCHRP Project 15-39, NCHRP Report 774

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_774.pdf

Superelevation Criteria for Sharp Horizontal Curves on Steep Grades

Sharp, horizontal curves on steep downgrades are a safety concern for vehicles, especially heavy vehicles. Examples where this combination occurs are interchange ramps, mountainous roads, and high-speed downgrades on controlled-access roadways. The combination of grade, pavement cross slope, and pavement friction can hinder a driver's ability to position the vehicle correctly without compromising vehicle control. Superelevation criteria, horizontal curvature, and other associated geometric criteria needed to be developed for situations where steep grades are located on sharp horizontal curves. The report provided Caltrans design guidance for steep grades to improve safety for drivers.

NCHRP Project 02-24, NCHRP Report 786

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_786.pdf

Assessing Productivity Impacts of Transportation Investments

State departments of transportation and other agencies must consider many more opportunities for improving their transportation systems than they have funding to implement. Agency staff uses various methods to evaluate the relative merits of investment options to determine which project will produce the greatest benefit for the public. These methods include multi-criteria analysis (MCA) and benefit-cost analysis (BCA). MCA involves rating and scoring proposed investments in terms of such criteria as life-cycle cost, environmental impact, and road-user safety. BCA estimates the economic value over the investment's lifetime. With both approaches, travel-time savings are typically a substantial component of the benefit attributed to the investment. These savings are enjoyed by the transportation system's users and impact the productivity of the region's specific businesses and labor force. Productivity gains for businesses are an important consequence of transportation system improvements, but current MCA and BCA practices do not consider the broad economic productivity gains attributable to transportation system improvements. Fast and reliable delivery of goods and services, for example, can reduce the need for delivery vehicles, warehouse space, and investment in equipment and facilities as well as increase the rate at which workers can complete their tasks. Many economic activities also could not continue without effective transportation facilities. The cumulative effect of multifactor productivity gains can influence the competitiveness of firms in a region and the attractiveness of the region for companies and workers considering relocation. Caltrans can use the new analysis methodology to better inform decision makers—regional transportation planning agencies, local government agencies, and elected officials—about alternative transportation projects that could yield a variety of benefits.

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, located at UC Davis, performs research leading to the development of innovative technologies, data, and methods for highway and civil infrastructure. It uses advanced robotics, automation, sensing, networking, and information technologies in developing methods for highway and civil infrastructure construction, maintenance, and operations. AHMCT's mission is to improve the safety, mobility, and reliability of California highways, achieve lean operations, and minimize the environmental impacts, while considering life-cycle assessments, sustainability, and cost-benefit analysis.

Highway maintenance and construction operations are labor intensive and can expose workers and travelers to the risk of injury. While these operations have become more efficient over the past several decades, they can still benefit from advanced mechanization and enhancements in communication, networking, and digitization technologies. AHMCT evaluates and deploys new and advanced technologies for existing Caltrans operations, with a focus of promoting safety and efficiency by developing human-assist machinery and tools that allow staff to perform operations without being on foot on highways.

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http://ahmct.ucdavis.edu

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 and 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 protect life safety and ensure that roadways and bridges 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.

LEARN MORE

http://peer.berkeley.edu

Partners for Advanced Transportation Technology

PATH, a research and development center at UC Berkeley, is a leader in Intelligent Transportation Systems (ITS) research, working in conjunction with experts in the fields of information technology, electrical engineering, electronics engineering, mechanical engineering, economics, transportation policy, and behavioral studies. In close collaboration with Caltrans, PATH executes a diverse portfolio of multidisciplinary transportation research projects with its staff, UC Berkeley faculty, and students.

PATH provides Caltrans the tools needed to meet its safety and mobility goals by conducting leading-edge research on transportation; evaluating and conducting controlled experiments and field operational tests; and developing public, private, and academic partnerships using the expertise of knowledgeable and experienced ITS research staff.

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www.path.berkeley.edu

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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www.ucprc.ucdavis.edu

University Transportation Centers

In FY 2013/14, Caltrans provided state match funding for five California UTCs. Two previously funded and operating UTCs, the University of California Transportation Center (UCTC) and the Mineta National Transit Research Consortium (MNTRC), received a one-time federal augmentation under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users. Three new UTCs were established in FY 2013/14: the METRANS Transportation Center; the University of California Center on Economic Competitiveness in Transportation (UCCONNECT); and the National Center for Sustainable Transportation (NCST). The new UTCs received federal funding under the Moving Ahead for Progress in the 21st Century Act.

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.

UCTC, led by 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

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

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 and Transportation Planning.

NCST, led by University of Caifornia, 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 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

Affiliate member includes:

- California State Polytechnic University, Pomona

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www.dot.ca.gov/newtech/utc

Research Task Summary

The Research Task Summary lists selected research tasks completed in FY 2013/14 and scheduled to be completed in FYs 2014/15 and 2015/16 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 2013/14

Research tasks scheduled to be completed in FYs 2014/15 or 2015/16

Design/Construction

Task ID	Task Title	DRISI Manager	End Date	Page #
0918	Development of Aesthetic, Low-Maintenance Guardrail System Alternatives	Caldwell, Christopher	10/01/14	-
2405	Evaluate Photo Speed Enforcement in California Work Zones	Nagra, Sukhdeep	06/30/15	-
2524	Validating the Effects of Collaborative Partnering on Major Capital Projects	Chung, Haniel	12/31/15	-
2530	Environmental Effects of Cured-in-Place Pipe Repairs	Benouar, Azzeddine	12/31/15	-

Design/Construction TPF

Task ID	Task Title	DRISI Manager	End Date	Page #
2294	Enhancements to the FHWA-FST2DH Two-dimensional Hydraulic Model, TPF-5(248)	Chung, Haniel	07/1/15	-
2454	Surface-water Model System, TPF-5(266)	Chung, Haniel	07/1/15	-
2455	Watershed Modeling System License Renewal Agreement, TPF-5(265)	Chung, Haniel	07/1/15	-

Environmental TPF

Task ID	Task Title	DRISI Manager	End Date	Page #
1580	Measuring the Performance of Stakeholders in the Transportation Development Process—Separate Surveys for 5 States, TPF-5(147)	Buendia, Robert	11/18/14	-
1578	FHWA Traffic Noise Model: Version 3.0 Software and Training, TPF-5(158)	Hunt, Harold	06/30/15	-
1579	Tire/Pavement Noise Research Consortium, TPF-5(135)	Hunt, Harold	12/31/15	-

Geotechnical/Structures

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2418	University of California, Los Angeles: Comparative Study of Model Predictions and Data from Caltrans/CSMIP Bridge Instrumentation Program: A Case Study on the Eureka-Samoa Channel Bridge	Lee, Peter	11/01/13	-
2578	Calibration of LRFD Geotechnical Axial (Tension and Compression) Resistance Factors for Driven Piles and Drilled Shafts	Shantz, Tom	12/31/13	-
1929	Pacific Earthquake Engineering Research Center (PEER) - Lifeline Partnership Phase 3	Shantz, Tom	06/30/14	-
2342	Creep and Shrinkage Effects on Columns	Sikorsky, Charles	10/31/14	-

Geotechnical/Structures (continued)

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2129	Pilot Field Deployment of the Fiber Reinforced Polymer Composite Snaplock Sign Structure	Sikorsky, Charles	12/30/14	-
2181	Compliance Crash Testing of the Caltrans Type 26 Bridge Rail (732SW)	Whitesel, David	12/31/14	-
2122	California Permit and Fatigue Truck Load Development and Calibration	Chung, Haniel	02/27/15	-
2316	Steel Girder End Panel Shear Resistance	Sikorsky, Charles	03/31/15	-
2107	Nondestructive Damage Evaluation of Viscous Dampers, Lead Rubber Bearings, and Friction Pendulum Bearings	Sikorsky, Charles	05/31/15	-
1805	Corridor-Scale Landslide Hazard Mapping: Conversion of California Geological Survey Hazard Maps	Roblee, Cliff	06/30/15	-
2532	Assessment of Soil Arching Factor for Retaining Wall Pile Foundations (Phase I)	Sikorsky, Charles	08/30/15	-
1946	Enhancement of National Load and Resistance Factor Design Codes for California Bridge Design: Hinge Curl Research	Ikram, Hamid	08/31/15	-
2111	Geophysical Methods for Determining the Geotechnical Engineering Properties of Earth Materials	Owen, Bill	03/31/16	-
2343	Reusable Instrumented Test Pile Phase 2	Shantz, Tom	03/31/16	-
2605	Reusable Instrumented Test Pile Phase 2 (subcontracting with Great West Drilling)	Shantz, Tom	03/31/16	-
2346	Controlling Temperature and Shrinkage Cracks in Bridge Decks and Slabs	Lee, Peter	05/01/16	-

Geotechnical/Structures TPF

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2024	Enhancement of Welded Steel Bridge Girders Susceptible to Distortion-Induced Fatigue, TPF-5(189)	Duan, Lian	08/31/13	-
0260	Soil Mixing Methods for Highway Applications, TPF-5(001)	Jang, David	09/30/13	-
2347	Imaging Tools for Evaluation of Gusset Plate Connections in Steel Truss Bridges, TPF-5(259)	Johnson, Michael	06/30/14	-
2401	Shaking Table Testing to Evaluate Effectiveness of Vertical Drains for Liquefaction Mitigation, TPF-5(244)	Shantz, Tom	06/30/14	-
2489	Passive Force-Displacement Relationships for Skewed Abutments, TPF-5(264)	Sikorsky, Charles	09/30/14	-
1010	Structural Acoustic Analysis of Piles, TPF-5(140)	Hunt, Harold	12/31/14	-
2444	Peer Exchange and Review of Deep Foundation Testing Methodologies at Caltrans, TPF-5(263)	Hunt, Harold	12/31/14	-
1648	Application of Three-Dimensional Laser Scanning for the Identification, Evaluation, and Management of Unstable Highway Slopes, TPF-5(166)	Meline, Bob	12/11/15	-

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2215	**Deployment Support and Caltrans' Implementation of the Sealzall Machine**	**Lofton, Arvern**	**12/31/13**	**30**
2338	**Continued Evaluation of Pothole Patching Equipment, Materials, and Processes**	**Lofton, Arvern**	**06/14/14**	**32**
1810	Field Operations for GPS-Assisted Winter Maintenance Vehicles	Baumeister, Larry	09/28/14	-
2336	Evaluation of the Tow Plow Trailer System	Baumeister, Larry	06/30/15	-

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2543	Validation of Polyester Concrete Rehabilitation Strategy to Extend the Service Life of Concrete Bridge Decks	Sahs, Steve	06/30/15	-
2337	Tioga 120 Pass Clearing (Eastern Side)	Baumeister, Larry	07/31/15	-
2167	Implementation and Evaluation of the Snowplow Driver Assistance System	Baumeister, Larry	08/30/15	-
2335	Improved Deicing Methods for Snow and Ice Removal: Epoke Evaluation	Baumeister, Larry	09/30/15	-
2516	Light Fleet In-vehicle Data Acquisition System Evaluation	Perez, Jose	09/30/15	-
2771	Avalanche Sensing System Testing and Evaluation	Baumeister, Larry	12/31/15	-
2732	Traction Control Device Study	Mizuno, Bradley	06/30/16	-
2737	Investigation of Division of Equipment Fleet Equipment Repair Costs and Replacement Criteria	Nagra, Sukhdeep	06/30/16	-

Maintenance TPF

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1729	In-Situ Scour Testing Device, TPF-5(210)	Ng, Steve	09/30/14	-
2403	Bridge Pier Scour Research, TPF-5(211)	Flora, Kevin	12/31/14	-
1050	Underwater Inspection of Bridge Substructures Using Underwater Imaging Technology, TPF-5(131)	Johnson, Michael	06/30/15	-
1132	Development of Maintenance Decision Support System, TPF-5(054)	Baumeister, Larry	09/30/15	-
1508	Western Maintenance Partnership, TPF-5(145)	Meline, Bob	06/30/16	-

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2508	Field Operational Tests of Vehicle-Assist and Automation System Using Full-size Public Transit Buses	Mizuno, Bradley	05/31/14	-
2274	**BART Air Freight: Phase 2**	**Hanson, Matt**	**06/30/14**	**34**
1912	Bay Area Airport Disaster Recovery Plan	Tyner, Patrick	09/30/14	-
2637	High Speed Rail Connectivity Planning	Tyner, Patrick	10/28/14	-
2333	Bus Rapid Transit Person Throughput-Vehicle Congestion Tradeoffs	Saetern, Lai	11/24/14	-
2631	Promoting Intermodal Connectivity at California's High Speed Rail Stations	Tyner, Patrick	12/31/14	-
2461	Smart Travel Choices—Field Operational Tests	Ziaullah, Fouad	01/31/15	-
2499	Pricing Your Way to Operational Efficiency: One-Way Electric Vehicle Carsharing in San Diego	Tyner, Patrick	05/30/15	-
1768	Integration of Automated Weather Observing System with Road Weather Information System Phase 2—Prepare System for Deployment	Clark, Melissa	03/31/16	-
2521	Dynamic Transit Trip Planner	Mizuno, Bradley	05/30/16	-

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2550	**Surface Treatment Macrotexture and Bicycle Ride Quality**	**Holland, Joe**	**03/03/14**	**36**
2261	Hauling the Caltrans' Heavy Vehicle Simulators	Rodriguez, Alfredo	06/10/14	-

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2352	Early-age Cracking Performance	Lim, David	06/30/14	-
2380	**Implementation of New Quieter Pavement Research**	**Lim, David**	**06/30/14**	**38**
2601	Implementation of New Quieter Pavement Research (continuing from Task 2380)	Lim, David	06/30/14	-
0295	Partnered Pavement Research Center Stage 2	Holland, Joe	09/30/14	-
2310	Coefficient of Thermal Expansion in Portland Cement Concrete Pavement Design and Specification	Lim, David	09/30/14	-
2354	Complete QA on Automated Pavement Condition Survey and GPR Contracts	Holland, Joe	09/30/14	-
2356	Updated Standard Materials Library	Sadraie, Hamid	09/30/14	-
2364	Certification of Inertial Profilers Used in Pavement Management System and Construction Monitoring	Holland, Joe	09/30/14	-
2374	Recycling of Rubberized Hot Mix Asphalt in Recycled Asphalt Pavement and Full Depth Recycling Projects and with Warm Mix Technologies	Sadraie, Hamid	09/30/14	-
2375	Monitoring of Selected Quieter Pavement Test Sections	Lim, David	09/30/14	-
2376	Use Environmental Life Cycle Analysis to Develop Tools and Recommend Practices to Reduce Environmental Impact	Holland, Joe	09/30/14	-
2482	Logistics Augmentation of Pilot Study Investigating the Interaction and Effects for State Highway Pavements, Trucks, Freight, and Logistics	Nokes, Bill	09/30/14	-
2500	Training Materials for New Pavement Management System	Holland, Joe	09/30/14	-
2558	Rubber Binder Testing and Acceptance	Sadraie, Hamid	09/30/14	-
2565	Blending Effects of Recycled Asphalt Pavements on Virgin Binders	Sadraie, Hamid	09/30/14	-
2580	Use Environmental Life Cycle Analysis to Develop Tools and Recommend Practices to Reduce Environmental Impact (Sustainable Pavements)	Holland, Joe	09/30/14	-
2599	Updated Standard Materials Library (continuing from Task 2356)	Sadraie, Hamid	09/30/14	-
2600	Monitoring of Selected Quieter Pavement Test Sections (continuing from Task 2375)	Lim, David	09/30/14	-
2603	Pilot Study Investigating the Interaction and Effects for State Highway Pavements, Trucks, Freight, and Logistics (continuing from Task 2482)	Nokes, Bill	09/30/14	-
2639	Verification of Pavement Structure and Deflection Effects on Vehicle Fuel Economy and GHG Emissions	Holland, Joe	10/31/14	-
2357	Update Life-Cycle Cost Analysis Manual with New Performance Data	Holland, Joe	12/31/14	-
2363	Effects of Milling and Other Repairs on Smoothness of Overlays	Holland, Joe	12/31/14	-

Pavement TPF

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1133	**Recycled Unbound Pavement Materials (MnROAD Study), TPF-5(129)**	**Lim, David**	**12/31/13**	**40**
1134	**Design and Construction Guidelines for Thermally Insulated Concrete Pavements, TPF-5(149)**	**Lim, David**	**12/31/13**	**42**
1583	Consortium of Accelerated Pavement Testing and Technical Exchange Partnership, TPF-5(127)	Holland, Joe	12/31/13	-
0887	**Development of Performance Properties of Ternary Mixes, TPF-5(117)**	**Holland, Joe**	**05/31/14**	**44**
0231	Pavement Subgrade Performance, SPR-2(208)	Rodriguez, Alfredo	11/30/14	-
1029	Portland Cement Concrete Surface Characteristics: Tire-Pavement Noise Part 3, TPF-5(139)	Dirrim, Peter	11/30/14	-

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2358	Performance Modeling Using New Caltrans Pavement Management System Data, TPF-5(284)	Holland, Joe	12/31/14	-
0375	Pavement Reconstruction Scheduling Software (CA4PRS), SPR-3(098)	Samadian, Michael	06/30/15	-
2258	Technology Transfer Intelligent Compaction Consortium, TPF-5(233)	Chung, Haniel	09/30/15	-
0296	Long-Term Pavement Performance Specific Pavements Study Data Collection, TPF-5(004)	Rodriguez, Alfredo	12/31/15	-
2020	Improving the Foundation Layers for Concrete Pavements, TPF-5(183)	Lim, David	06/30/16	-

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2243	**Spatially Focused Travel Survey Data Collection and Analysis**	**Justice, Bob**	**07/30/13**	**46**
2622	**California Integrated Border Approach Study (CA-IBAS)**	**Azevedo, Christine**	**07/30/13**	**48**
2200	**Non-Motorized Travel: Analysis of the 2009 NHTS California Travel Survey Add-On Data**	**Justice, Bob**	**12/31/13**	**50**
2387	**Near-Term Transportation Energy and Climate Change Strategies**	**Tyner, Patrick**	**12/31/13**	**52**
1919	**Research and Development of an E85 Alternative Fuel Monitoring System**	**Saetern, Lai**	**03/31/14**	**54**
1940	**California Smart-Growth Trip-Generation Rates Study**	**Williams, Scott**	**03/31/14**	**56**
2329	**Deployment of Prior HOV Lanes Research Results in Developing Analysis Tools for New Managed Lanes Projects**	**Tyner, Patrick**	**03/31/14**	**58**
2330	**Developing a Model to Quantify Emissions from Heavy-Duty Construction Equipment**	**Tyner, Patrick**	**04/30/14**	**60**
2636	Transportation Futures for Deep Greenhouse Gas Reductions: Synergistic Interactions of New Transportation Technologies and Services with Land Use, Transit, and Auto Pricing Policies, Year 2	Tyner, Patrick	12/31/15	-
2648	Accounting for Interregional Travel in Regional Land Use and Transportation Plans: A Comparison of Attribution Methods	Tyner, Patrick	12/31/15	-
2483	Alternative Transportation Funding Study	Williams, Scott	12/30/14	-
2309	Next STEPs: Scenarios and Transition Strategies	Tyner, Patrick	06/14/15	-
2536	Clean, Green, and Smart Corridor Development—MCOM Advance Adoption of Alternative Fuel Commercial Vehicles	Hanson, Matt	09/30/15	-
2635	The Impact of Public Bikesharing on Bicycle Safety in North America	Rudulph, Kimberly	10/31/15	-
2645	Balancing Life-cycle Cost and Life-cycle Impact Considerations in Pavement Management	Holland, Joe	01/31/16	-

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1651	**Mobile Source Air Toxics (MSAT) from Major Highways, TPF-5(170)**	**Tyner, Patrick**	**12/31/13**	**62**
2515	2014 Transportation Asset Management Conference and Training on Implementation Strategies, TPF-5(275)	Williams, Scott	01/01/15	-

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2517	**Mobile Terrestrial Laser Scanning Workflow Development, Technical Support and Evaluation**	**Lofton, Arvern**	**06/14/14**	**64**
2194	Application of Mobile Laser Scanning for Lean and Rapid Highway Maintenance and Construction	Lofton, Arvern	09/30/14	-

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1746	**Professional Capacity Building for Communication Systems Phase II**	**Perez, Jose**	**10/31/13**	**66**
1752	COATS Phase V—Western Transportation Institute	Campbell, Sean	08/14/14	-
2526	Evaluation of an Animal Warning System Effectiveness, Phase 3: Equipment Removal	Loebs, Nathan	12/01/14	-
2328	Hand-Held Diagnostic Controller for ITS Field Maintenance	Campbell, Sean	12/31/14	-
1747	Professional Capacity Building for Communication Systems Phase III: Telco Wireless Communications	Perez, Jose	12/29/15	-
2283	WeatherShare Phase III: Visualization Tools	Campbell, Sean	12/31/15	-
1846	Responder Study Phase III: Enhancements, Specifications, and Deployment	Clark, Melissa	03/31/16	-
1753	COATS Phase VI	Campbell, Sean	06/30/16	-

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2246	Western States Rural Transportation Consortium, TPF-5(241)	Campbell, Sean	06/30/16	-

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2416	**Seismic Responses of Mechanically Stabilized Earth Walls Using Accelerated Alternative Backfill Materials with Recycled Tire Shreds and Lightweight Expanded Aggregates**	**Lee, Peter**	**07/16/13**	**68**
2176	**Next Generation of Bridge Columns for Accelerated Bridge Construction in High Seismic Zones**	**Lee, Peter**	**12/31/13**	**70**
2240	**Required Embedment Length of Column Reinforcement Extended into Type II Shafts**	**Sikorsky, Charles**	**12/31/13**	**72**
2179	**Repair of Earthquake-Damaged Columns with Fractured Bars**	**Lee, Peter**	**03/31/14**	**74**
2280	**Probabilistic Damage Control Approach for Seismic Design of Bridges**	**Lee, Peter**	**05/31/14**	**76**
2281	**Experimental and Analytical Seismic Studies of Bridge Piers with Innovative Pipe Pin Column-Footing Connections and Precast Cap Beams**	**Lee, Peter**	**05/31/14**	**78**
2421	Benchmarking Recently Developed Procedures for Designing Pile Foundations in Laterally Spreading Ground	Sikorsky, Charles	07/31/14	-
2424	Development of a Rational Design Method for Shear Keys at In-Span Hinges in Multi-Frame Highway Bridges	Sikorsky, Charles	08/31/14	-
2266	Guidelines for Nonlinear Seismic Analysis of Ordinary Bridges: Version 2.0	Lee, Peter	09/14/14	-
2419	Efficient Nonlinear Time History Analysis of Ordinary Bridges	Sikorsky, Charles	11/30/14	-

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2493	Interaction of Mechanically Stabilized Earth Abutments with Superstructures Under Seismic Loading (Phase I)	Sikorsky, Charles	11/30/14	-
2264	Development and Verification of Concrete Models for Pier Walls and Hollow Columns (Analytical Phase)	Sikorsky, Charles	12/15/14	-
2265	Seismic Performance of Connections That Facilitate Accelerated Bridge Construction	Sikorsky, Charles	12/30/14	-
1793	Deployment and Implementation Support for ShakeCast	Turner, Loren	12/31/14	-
2417	Concrete-Filled Tube Bridge Pier Connections for Accelerated Bridge Construction	Lee, Peter	03/15/15	-
2171	The Stiffness Provided by Girders, Decks, and Soffits	Lee, Peter	06/15/15	-
2456	Bridge Strong Motion Instrumentation	Hipley, Pat	06/28/15	-
2420	Seismic Assessment of Cut and Cover Tunnels	Sikorsky, Charles	07/31/15	-
2562	Evaluation of Durability and Wear Characteristics of Viscous Fluid Dampers	Sikorsky, Charles	07/31/15	-
2263	Evaluation and Improvement of Design Methods and Details for Shear Keys and Stem Walls in Bridge Abutments	Sikorsky, Charles	09/30/15	-
2560	Evaluate the Development Length for Headed Steel Reinforcing Bars	Sikorsky, Charles	09/30/15	-
2287	Analytical and Experimental Development of Bridges with Foundations Allowed to Uplift During Earthquakes	Lee, Peter	10/31/15	-
2423	Performance of the Column-to-Shaft Pin Connections in Type-II Shafts	Sikorsky, Charles	11/30/15	-
2563	Evaluate Grade 80 Steel Reinforcement Bars for Seismic Applications	Sikorsky, Charles	12/31/15	-
2425	Nonlinear Lateral Performance of Skew Abutments	Lee, Peter	05/31/16	-

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Transportation Safety and Mobility

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2272	**Field Test the Effectiveness of Adaptive Traffic Control for Arterial Signal Management**	**Slonaker, John**	**08/31/13**	**80**
2223	**Coordination of Freeway Ramp Meters and Arterial Traffic Signals Field Operational Test**	**Aboukhadijeh, Hassan**	**12/31/13**	**82**
2209	**Pedestrian Safety Improvement Program**	**Kwong, Jerry**	**03/31/14**	**84**
2302	**Developing a Plan to Collect Pedestrian Infrastructure and Volume Data for Future Incorporation into Caltrans Accident Surveillance and Analysis System Database**	**Hassas, Roya**	**05/31/14**	**86**
1934	**Weave Analysis Matrix and Microsimulation Methodology Refinement**	**Perez, Jose**	**06/13/14**	**88**
1798	Develop Options for a California Weigh in Motion Test Facility	Saetern, Lai	06/30/14	-
2297	**California IntelliDrive Test Bed Upgrade (Federal Portion)**	**Siddiqui, Asfand**	**06/30/14**	**90**
2307	California IntelliDrive Test Bed Upgrade (State Portion)	Siddiqui, Asfand	06/30/14	-
2245	Quick Clearance for Major Traffic Incidents—Baseline Study	Clark, Melissa	12/30/14	-
2206	Crash Attenuator Data Collection and Life-cycle Tool Development	Her, Vue	12/31/14	-

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2317	Development of Safety Performance Functions for California	Kwong, Jerry	01/31/15	-
2293	Enhancement and Technical Support of Intelligent Roadway Information System in Caltrans Districts 1, 2, 5, and 10	Clark, Melissa	03/31/15	-
2564	Assist in the Development and Support of an Enterprise-Wide Traveler Information System (In-House Research)	Campbell, Sean	03/31/15	-
1831	Truck Access and Parking: Improved Parking Information and Reservations for Truckers	Hanson, Matt	06/30/15	-
2087	Advanced Research Bluetooth Travel Time System	Palen, Joe	06/30/15	-
2165	San Diego Integrated Corridor Management, Phase 3 Demonstration and Evaluation	Perez, Jose	06/30/15	-
2257	Work Zone Injury Data Collection and Analysis	Ikram, Hamid	06/30/15	-
2529	Advanced Traffic Signal Control Algorithms, Phase 2	Siddiqui, Asfand	08/31/15	-
2234	Dedicated Short Range Communications for Work Zones and Major Incident Management	Gwynne, Gloria	09/15/15	-
2841	Testing MS Sedco INTERSECTOR Radar Detectors for Car and Bike Discrimination	Slonaker, John	10/30/15	-
2449	Queue Storage and Acceleration Lane Length Design at Metered On-Ramps in California	Perez, Jose	10/31/15	-
2535	Coordination of Freeway Ramp Meters and Arterial Traffic Signals (Phase IIA); Site Selection and Simulation Development	Aboukhadijeh, Hassan	12/31/15	-
2445	Field Experiment of Coordinated Ramp Metering— Phase II	Aboukhadijeh, Hassan	01/31/16	-
1546	C1 Loop Detector Reader/Analyzer	Loebs, Nathan	06/30/16	-
1559	Onsite Evaluation of Roadside Devices and Operational Strategies	Palen, Joe	06/30/16	-

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2289	**Evaluation of Sign Guide Fonts, TPF-5(262)**	**Hanson, Matt**	**04/15/14**	**92**
2579	Support of Research and Deployment of System Ops Applications of VII, TPF-5(206)	Siddiqui, Asfand	12/31/14	-
0788	Traffic Control Devices, TPF-5(065)	Perez, Jose	05/01/15	-
2081	Urban Mobility Study, 2009 continuation—TTI, TPF-5(198)	Perez, Jose	08/31/15	-
2318	Highway Safety Manual Implementation, TPF-5(255)	Kwong, Jerry	09/30/15	-
0373	High Occupancy Vehicle Systems Study, TPF-5(029)	Loebs, Nathan	12/31/15	-
1057	TTI Roadside Safety Research Program, TPF-5(114)	Jewell, John	12/31/15	-
2306	Traffic Signal Systems Operations and Management Study, TPF-5(258)	Clark, Melissa	12/31/15	-
2061	Support for Research and Deployment of System Ops Applications of VII, TPF-5(206)	Siddiqui, Asfand	12/31/16	-

Fiscal Year 2013/14
Research Results

For this report, DRISI selected a few 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 access and 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

Maintenance

Implementing Automated Machinery for Sealing Pavement Cracks

Sealzall machine increases productivity and safety when repairing longitudinal highway cracks

NOVEMBER 2014

Project Title:
Deployment Support and Caltrans' Implementation of the Sealzall Machine

Task Number: 2215

Start Date: July 1, 2012

Completion Date: December 31, 2013

Product Category: Evaluation of new commercial products to determine if they meet Caltrans needs; new tool; improved procedure

Task Manager:
Arvern Lofton
Transportation Engineer, Electrical
arvern.lofton@dot.ca.gov

WHAT WAS THE NEED?

The majority of highway cracks are longitudinal, running the length of the roadway parallel to the pavement centerline. Unsealed cracks can lead to premature pavement deterioration. Timely maintenance helps retain the structural integrity of the roadway and extends the time between pavement replacements. Caltrans currently seals all cracks manually, a labor-intensive process requiring several dedicated crews and lane closures. Workers are also exposed to highway traffic and hot sealant material. To improve worker safety and increase productivity, Caltrans explored mechanizing crack-sealing operations.

WHAT WAS OUR GOAL?

The goal was to test innovative crack-sealing equipment capable of high-production longitudinal sealing and enhanced manual in-lane sealing to increase efficiency and worker safety.

The Sealzall longitudinal sealing operation produces a uniform and smooth seal, shown here on Interstate 15 in Escondido.

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Davis Advanced Highway Maintenance & Construction Technology Research Center, field-tested the Sealzall automated crack-sealing machine. District 11 maintenance crews used the machinery for one year and provided the researchers feedback. The research team summarized the results, which includes recommendations for preparing and cleaning cracks, suggested options for future Sealzall deployments, and a lifecycle cost-benefit analysis.

Caltrans provides a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability.

WHAT WAS THE OUTCOME?

The Sealzall is much more productive and efficient than the manual method of longitudinal crack sealing. Maintenance operators inside the cab of the Sealzall truck can seal 5–8 linear miles in one day, compared to only one linear mile a day manually. Operation is continuous, with moving lane closures, thus reducing the need to coordinate with the California Highway Patrol for fixed lane closures and the resulting impact on traffic.

Caltrans District 11 maintenance managers requested that the Sealzall deployment continue to complete two current projects to longitudinally seal about 200 lane miles of new shoulder joints.

WHAT IS THE BENEFIT?

The Sealzall increases productivity by about 500% over manual methods while eliminating worker exposure to traffic and reducing the need for lane closures. Crew members work from within the truck and do not need to interact with high temperature sealant. Because the machine operates in a continuous motion, traffic delays are minimized. In addition to the safety features, Caltrans could gain substantial savings per year in longitudinal crack sealing costs.

Sealzall also improves the safety of in-lane manual sealing operations because crew members are more clearly in view of oncoming traffic.

Cost to Seal 2,161 Longitudinal Lane Miles per Year		
	Sealzall	**Manually**
Sealant cost	$1,452,192	$1,452,192
Number of crews (5-person crew on average)	2	12
Operational cost rate per crew	$1,696	$1,619
Operational cost per day	$3,392	$19,428
Average number of miles sealed per day	6	1
Total operational cost (180 work days/year)	$610,560	$3,497,040
Exposure safety cost per year (workers on foot)	$0	$42,100
Injury costs (workers on foot)	$0	$9,366
Traffic impact cost per year	$207,115	$1,242,575
Calculated total cost per year	$2,269,867	$6,243,273
Caltrans cost savings per year	$4 million	

Data results from the Caltrans District 11 deployment trials

LEARN MORE

To view the complete report:
http://ahmct.ucdavis.edu/pdf/UCD-ARR-13-06-30-03.pdf

For additional information about the project:
http://ahmct.ucdavis.edu/wp-content/uploads/pdf/SealzallDeployment%202-pager.pdf

Results of a Sealzall manual sealing operation on Interstate 8 in Winterhaven

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Research Results

Maintenance

Evaluating Automatic Pothole Patching Equipment

Automated pothole patching machines reduce worker exposure to traffic and improve the repair process

FEBRUARY 2015

Project Title:
Continued Evaluation of Pothole Patching Equipment, Materials, and Processes

Task Number: 2338

Start Date: July 1, 2012

Completion Date: June 14, 2014

Product Category: Evaluation of new commercial products to determine if they meet Caltrans' need

Task Manager:
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WHAT WAS THE NEED?

The typical pothole repair procedure consists of a maintenance worker quickly moving onto the roadway during a brief traffic break, placing cold patch asphalt into the hole, and retreating after compacting the repair material a few times with a shovel or boot. This manual process directly exposes workers to highway traffic. After two workers were killed in separate incidents while patching highway potholes, Caltrans researched using automated equipment to reduce worker exposure when performing highway patching operations. In a previous project, the Python Pothole Patcher, which automates the traditional hot asphalt patch process, was tested, during which issues arose that required more evaluation to ensure that the Python machine met Caltrans' needs and safety concerns.

WHAT WAS OUR GOAL?

The goal was to have an automated pothole patching machine customized to meet Caltrans specific operational requirements of ease of use, worker safety, and cost efficiency.

Python PHP 5000 Pothole Patcher during testing

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WHAT DID WE DO?

Caltrans, in partnership with the University of California, Davis Advanced Highway Maintenance and Construction Technology (AHMCT) Research Center, collaborated with Python Manufacturing to resolve various items with its automated Pothole Patcher (PHP), including issues with the machine's drive power train and the conveyor belt systems. The PHP was then successfully deployed in District 4. For example, during one deployment operation, workers were able to fill 75 potholes and seven longitudinal voids in two hours, demonstrating unprecedented pothole patching productivity and efficiency with minimal impact on roadway traffic by using rolling lane closures. The research team also completed a conceptual design of the injection nozzle assembly.

The researchers also investigated other cab-operated products that use a spray patching process: the Rosco RA-300 Spray Patch Machine, the JMK Spray Patcher, and the DuraMaxx Pothole Patcher.

Python automated hot asphalt patching

WHAT WAS THE OUTCOME?

Following a successful 1.5 year deployment trial in San Jose, District 4 maintenance crews were impressed with the PHP's production capabilities while keeping workers off the roadways. However, in July 2013, the unit was removed from service due to safety and handling concerns expressed by Headquarters Maintenance. As a result, the research on this project ended.

Caltrans Maintenance is still interested in obtaining pothole patching equipment for moving-closure mainline pothole repair operations. Caltrans wants to evaluate other commercially available pothole patching equipment that meets California Air Resources Board emission standards.

WHAT IS THE BENEFIT?

Compared to manual pothole patching processes, an automated pothole patching machine increases efficiency and quality, makes rolling highway closure patching operations possible, and minimizes the impact on traffic congestion. By eliminating full lane closures and reducing worker exposure in the roadway, safety is improved for both maintenance staff and motorists.

LEARN MORE

To view the complete report:
http://ahmct.ucdavis.edu/?projects=python-pothole-repair

Manual pothole patching

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Research Results

Moving Air Freight via BART

Is it feasible to use BART instead of trucks to move freight in and out of San Francisco and Oakland airports?

Modal

NOVEMBER 2014

Project Title:
BART Air Freight—Phase 2

Task Number: 2274

Start Date: November 15, 2010

Completion Date: June 30, 2014

Product Category: New business practice, procedure, or process

Task Manager:
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WHAT WAS THE NEED?

Air cargo in the San Francisco Bay Area continues to increase, spurred on with the growth of online purchases. Trucks are the primary mode for moving air freight between airports, sorting sites, distribution centers, and customers. However, trucks exacerbate peak period congestion, safety, and air quality in the vicinity of the major highways in and around the airports. Moving goods with trucks generates emissions not only while driving but also when idling during loading and unloading cargo. From the perspective of the air freight carriers, it is challenging to predict delivery times when trucks are subject to roadway congestion—delivery delays affect service quality and cause a loss of revenue. These concerns can be mitigated by using other transportation modes to move goods.

On average, the Bay Area Rapid Transit (BART) system has 63% unused capacity during non-peak hours. Using a portion of the unused capacity to transport freight would decrease truck traffic and the resulting impacts and allow for a more timely and predictable delivery of goods.

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WHAT WAS OUR GOAL?

The goal was to check the feasibility of using alternative means to transport air freight deliveries to reduce truck activities.

WHAT DID WE DO?

Caltrans worked with various stakeholders, including air freight carriers, to study the feasibility of using BART to move freight in and out of San Francisco and Oakland airports. The researchers assessed the technical, operational, and institutional changes that would need to be made to BART to accommodate freight. They investigated transshipment logistics between air freight carriers and BART, including security considerations for both BART and the freight carriers. The research also explored opportunities to demonstrate a small scale freight transport operation.

WHAT WAS THE OUTCOME?

It is feasible to concurrently operate a freight service and passenger service on BART. BART and the air freight carriers have similar operational needs in terms of trip time reliability, safety, and security. The biggest and most expensive obstacle is retrofitting the BART infrastructure to facilitate efficient freight movement between the different transport modes.

The research also produced a template for how to examine a train transit system for its potential to transport time-sensitive goods, providing a stepping stone for integrating freight movement into transit operations in California and nationwide.

WHAT IS THE BENEFIT?

Switching from a highway freight transport system to a rail-based system has the potential to improve highway safety, reduce emissions and fuel use, provide higher trip-time reliability to the air freight carriers, and offer BART a new revenue stream. Additionally, BART runs on electric power, a cleaner source of energy than diesel fuel. Utilizing BART's existing excess capacity reduces the demand for limited highway capacity. The fact that BART runs continually also offers freight carriers more flexibility as a transshipment option, especially if air cargo is delayed, because it is not necessary to dispatch additional trucks to pick up late loads.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2015/final_report_task_2274.pdf

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Research Results

Pavement

Effect of Pavement Surface Treatments on Bicycle Ride Quality

Using different surface treatments can reduce vibration and improve ride quality

NOVEMBER 2014

Project Title:
Surface Treatment Macrotexture and Bicycle Ride Quality

Task Number: 2550

Start Date: February 4, 2013

Completion Date: March 3, 2014

Product Category: Improved technical standard, plan, or specification

Task Manager:
Joe Holland
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WHAT WAS THE NEED?

Caltrans uses chip seals as a preventative maintenance strategy to extend a pavement's service life and to protect against water intrusion and oxidation. Chip seals, also called seal coats, are constructed by distributing a thin base of hot bitumen or asphalt onto an existing pavement and then embedding graded aggregate into it. Although the aggregate is rolled to create a smooth surface, it has a rougher texture than a typical asphalt surface, causing increased vibration for bicycles and rolling resistance for both vehicles and bicyclists.

In 2012, Caltrans placed a chip seal on about a 20-mile stretch of State Route (SR) 1 between Cambria and the Monterey County line. Shortly after completion, bicyclists alerted Caltrans about the poor ride quality. In response, Caltrans evaluated different chip seal treatments and techniques to reduce vibration and improve the ride quality.

WHAT WAS OUR GOAL?

The goal was to address the impact of chip seals on bicyclists and evaluate various means to improve the ride quality.

Bicycle instrumented with accelerometers

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Effect of Pavement Surface Treatments on Bicycle Ride Quality

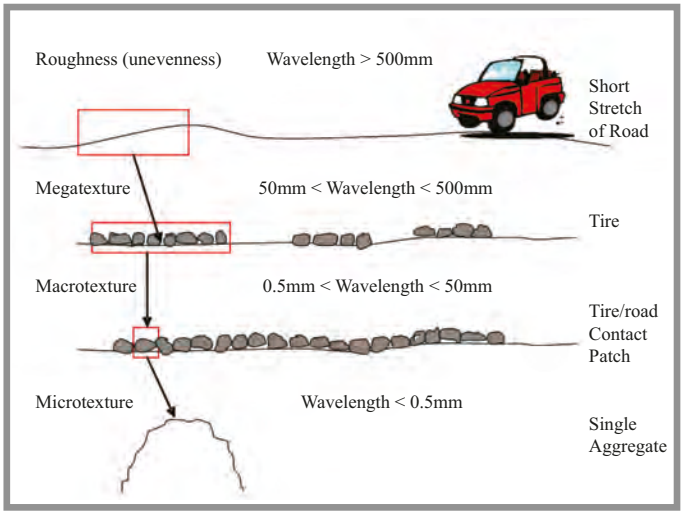
Research Results

WHAT DID WE DO?

Caltrans, in partnership with the University of California Pavement Research Center (UCPRC), evaluated the pavement surface texture and compared it to bicyclist surveys regarding ride quality and actual bicycle vibrations measured with mounted accelerometers. The researchers set up test sections on SR 198 in Monterey using different treatments applied to the existing 3/8-inch chip seal, similar to the chip seal on SR 1. They also assessed the effectiveness of different techniques to smooth the texture, such as using steel rollers during chip seal construction and additional rubber-tired rolling after construction. Each section was evaluated for bike riding quality by cyclists via surveys and measured bicycle vibrations.

WHAT WAS THE OUTCOME?

The surface texture and vibration values of the test treatments on SR 198 measured lower than the untreated chip seal section. Cyclist surveys taken on the test sections also indicated acceptable rides as correlated to surface texture and vibration levels. Additional rubber-tire rolling months after construction seemed to produce only a small reduction in vibration. Based on the results of this study, specific vibration levels, pavement surface texture values, and bicycle riding quality models were established. Caltrans and the UCPRC will leverage this work by performing similar research for urban pavement treatments and bicycles.



Pavement surface texture components and their wavelengths (500 mm = 1.64 ft, 50 mm = 0.164 ft or 2.0 in., 0.5 mm = 0.02 in.)

WHAT IS THE BENEFIT?

By adding an additional surface treatment, it is possible to construct a chip seal that offers cyclists a smoother ride. Transportation agencies can continue using the cost-effective chip seal treatment to preserve pavements while maintaining a bicycle-friendly surface.

LEARN MORE

To view the complete report:
www.ucprc.ucdavis.edu/PDF/UCPRC-RR-2013-07.pdf

Measuring the pavement macrotexture with a laser texture scanner

Instrumented vehicle with inertial profiler

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Research Results

Evaluating Mix Designs for Quieter Pavements

New mixes offer superior noise reduction and mechanical durability

Pavement

FEBRUARY 2015

Project Title:
Implementation of New Quieter Pavement Research: Accelerated Pavement Testing and Laboratory Evaluation of Different Open-Graded, Hot-Mix Asphalt Materials

Task Number: 2380

Start Date: November 1, 2011

Completion Date: June 30, 2014

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

Task Manager:
David Lim
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WHAT WAS THE NEED?

Caltrans began the Quieter Pavement Research program in 2007, a long-term effort to develop specifications, guidelines, and standardized laboratory and field test methods to be incorporated into standard Caltrans practices and lead to quieter pavements. Based on an earlier laboratory study, several open-graded friction course (OGFC) mixes that had performed well in the laboratory in terms of durability and sound absorption were selected for further evaluation.

WHAT WAS OUR GOAL?

The goal was to continue developing specifications, guidelines, and other information needed to incorporate quieter pavement research into standard Caltrans practice.

Heavy Vehicle Simulator used for testing

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WHAT DID WE DO?

Caltrans, in partnership with the University of California Pavement Research Center evaluated selected mixes using a Heavy Vehicle Simulator (HVS) and laboratory testing on plant-produced materials. The tests examined three new OGFC mixes, with the Caltrans mix serving as the control.

The tests included various performance grade (PG) and polymer-modified (PM) asphalt binders.

- Caltrans 3/8 inch mix with PG 76-22PM binder, average as-built thickness = 0.06 feet
- #4P mix with PG 76-22PM binder, average as-built thickness = 0.06 feet
- #4P mix with PG 76-22PM binder, average as-built thickness = 0.07 feet
- #4P mix with PG 64-16 binder, average as-built thickness = 0.05 feet
- Georgia 1/2 inch mix with PG 58-34PM, average as-built thickness = 0.15 feet

The #4P mixes had a nominal maximum aggregate size of 4.75 mm. The "P" indicates a coarser aggregate gradation identified in an earlier lab study.

The researchers studied the mixes' performance in terms of their constructability, rutting, moisture damage susceptibility, surface texture, permeability, clogging susceptibility, clogging and rutting mechanisms, and tire-pavement noise.

WHAT WAS THE OUTCOME?

While all the mixes are feasible depending on the type of project, preliminary indications revealed the following differences in performance:

- The #4P mixes offer superior noise and mechanical durability compared to the control mix, with similar skid resistance and surface permeability. They have lower macrotexture than the control, but more than dense-graded mixes. A rubberized binder might improve moisture sensitivity and rutting performance, which were better or worse than the control depending on the binder type.
- The Georgia 1/2-inch mix is likely to provide superior skid resistance and rutting performance compared to the control mix, although it could not be fully investigated due to difficulties in getting it produced by local plants as designed. This mix might also cost more because the Georgia department of transportation recommends lime treatment and fibers in addition to the polymer-modified binder.

WHAT IS THE BENEFIT?

Highway noise abatement is an ongoing effort. Caltrans now has guidelines for implementing specific types of quieter pavements, which provide an option to enhance current standard measures to reduce tire-pavement noise. Findings from this study can improve practices for designing and constructing quieter pavements while optimizing safety, durability, and cost.

LEARN MORE

To view the complete report:
www.ucprc.ucdavis.edu/PDF/UCPRC-RR-2013-04.pdf

Georgia 1/2-inch mix with PG 58-34PM; OGFC thickness = 0.15 feet

#4P mix with PG 76-22PM; OGFC thickness = 0.07 feet

Surface of two HVS test sections showing different residual permeability during 0.17 inches of rain

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Research Results

Using Recycled Materials in Roadway Foundations

Better understanding of the properties of recycled materials helps achieve more cost-effective use of resources

Pavement

NOVEMBER 2014

Project Title:
Recycled Unbound Pavement Materials (MnROAD Study), TPF-5(129)

Task Number: 1133

Start Date: May 25, 2007

Completion Date: December 31, 2013

Product Category: New business practice; new data

Task Manager:
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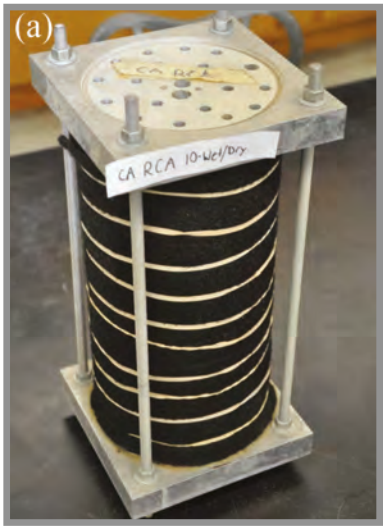
WHAT WAS THE NEED?

The pavement layer of a road is supported by layers of aggregate materials consisting of gravel, crushed rock, and sand. With these materials being depleted in the United States, it is becoming increasingly common to recycle pavement that has reached the end of its service life. Most state departments of transportation (DOT) allow using recycled materials, such as reclaimed asphalt pavement (RAP) and recycled concrete aggregate (RCA), in road foundations, and current design procedures assume that recycled materials have similar properties to those of typical virgin aggregates. However, it is not well understood how the properties of recycled materials, including strength, stiffness, and sensitivity to climate, affect pavement performance. In addition, the use of crushed concrete has raised some environmental concerns in terms of potentially leaching hazardous contaminants to the ground. This pooled-fund study was initiated to understand the properties of recycled unbound pavement materials to better predict performance and ensure that the materials are environmentally safe.



California RCS lab test samples

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Using Recycled Materials in Roadway Foundations

WHAT WAS OUR GOAL?

The goal was to assess how the properties of recycled materials used in aggregate base layers of roadways affect pavement performance and the environment.

WHAT DID WE DO?

Caltrans, as part of this pooled fund study with the Michigan, Minnesota, Ohio, Texas, and Wisconsin DOTs, supported the lab and field test programs. The research team at the University of Wisconsin at Madison conducted lab tests on both RAP and RCA samples from eight geographically diverse states and monitored newly constructed field test sections at a Minnesota DOT facility. A conventional Class 5 gravel base course was used as a control. The researchers investigated the following properties:

- Grain size distribution, fines content, asphalt content (RAP only), mortar content (RCA only), specific gravity, absorption, and impurities
- Proctor test compaction characteristics, plastic deformation, resilient modulus, and the effects of varying compaction and freeze-thaw cycling on resilient modulus
- Hydraulic properties, and for RCA, pH and metal leaching characteristics
- Mechanical properties under different climatic conditions as well as the effect of wet-dry cycling on particle degradation
- Deflection of various aggregate base course materials from 2009–13 via falling weight deflectometer tests, from which moduli were back-calculated

WHAT WAS THE OUTCOME?

RAP and RCA pass all necessary standards for being a suitable base course material. They are structurally and mechanically comparable, if not superior, to many natural aggregates. The RAP and RCA resilient moduli are higher than the natural aggregates used as a control material. Brick content of up to 30% in RCA did not affect resilient modulus. All materials have high drainage capacities, with RAP having the highest, followed by natural aggregate and RCA. The hydraulic properties are similar or superior to that of natural aggregate, and they similarly withstand the extreme effects of climate. However, some RAP might be sensitive to temperature change, potentially leading to rutting. Leachate slightly exceeded Environmental Protection Agency drinking water maximum contaminant levels on only a few occasions for all materials—these measurements are for the base layer; metal levels would be expected to fall before reaching groundwater.

WHAT IS THE BENEFIT?

As nonrenewable resources become more scarce, it is increasingly important to investigate the use of recycled materials in pavement design. This study produced extensive data on the properties of recycled paving materials and how they affect performance when used in unbound aggregate base layers. It also addressed environmental concerns to mitigate the possible ill effects of effluent from recycled concrete. Engineers can use the data to broaden the application of mechanistic-empirical pavement design methods to more accurately predict pavement performance and optimize resources.

LEARN MORE

To view the complete report and other information regarding this pooled fund study:
www.pooledfund.org/Details/Study/361

Stockpiles of recycled pavement materials

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Research Results

Asphalt Overlays on New Concrete Pavements

Are composite pavements cost-effective?

Pavement

DECEMBER 2014

Project Title:
Design and Construction Guidelines for Thermally Insulated Concrete Pavements, TPF-5(149)

Task Number: 1134

Start Date: January 1, 2007

Completion Date: December 31, 2013

Product Category: New or improved manual, handbook, guidelines, or training; new or improved decision support tool, simulation, or model

Task Manager:
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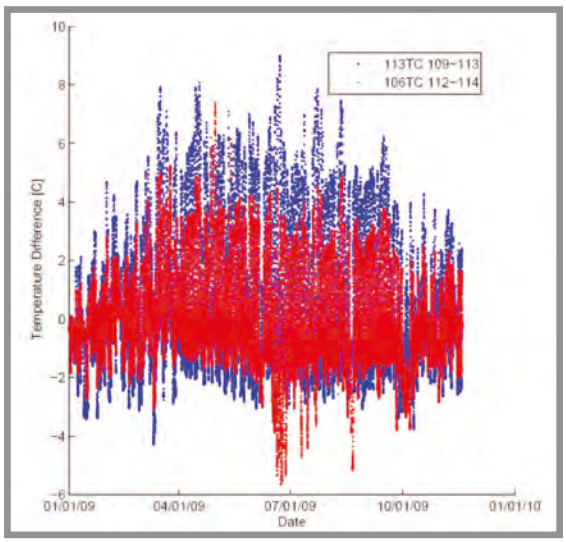
WHAT WAS THE NEED?

Thermally insulated concrete pavement (TICP) combines the structural longevity of portland cement concrete pavement with the serviceability of asphalt concrete pavement. TICP is a composite pavement consisting of a cement structure, either jointed or continuously reinforced, covered by an asphalt layer during or shortly after construction to provide easier maintenance and an insulating layer to reduce the magnitude of thermal loading. One of the perceived benefits of TICPs is that with the asphalt concrete overlay, it is possible to use a thinner portland cement layer and simplified concrete finishing and joint formation techniques. Despite these potential benefits, TICP has not been widely adopted, mainly because the initial construction costs are higher, and engineers have a limited understanding on the applications of mechanistic-empirical (ME) methodology for its design and construction. Improved design and construction guidelines based on ME methodology are needed for applications in which TICPs are economically advantageous.

WHAT WAS OUR GOAL?

The goal was to compare TICP life-cycle costs with alternative strategies and to develop guidelines for ME design and construction.



Thermal gradients at similar locations in asphalt concrete over portland cement concrete (in red) and jointed plain concrete pavement (in blue)

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WHAT DID WE DO?

Caltrans supported this pooled fund study with the Minnesota and Washington departments of transportation. The research team at the University of Minnesota and the University of California, Davis Pavement Research Center jointly investigated the life-cycle costs and performance of TICPs. The research included evaluating how the behavior of concrete and asphalt layers and their interaction and environmental and climatic conditions affect performance. The researchers also reviewed the influence of design, material properties, and construction on performance using field data collected from the TICP test sections.

WHAT WAS THE OUTCOME?

The researchers uncovered the source of faulty predictions in transverse cracking in asphalt overlay projects and made corrective recommendations. The team developed new ME models for reflective cracking, rutting, faulting, and transverse cracking for composite pavements. The proposed construction guidelines include criteria for the asphalt mixture to mitigate reflective cracking, rutting, and low-temperature cracking.

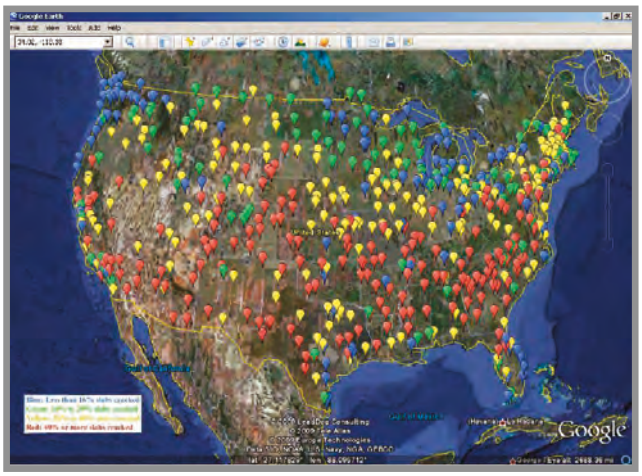
The cost efficiency of TICP depends on several factors. For example, as the cost of asphalt increases, the cost of other materials, most notably the concrete used for the structural layer, must decrease to make the TICP competitive. However, lowering the cost of the portland cement concrete layer by making the layer thinner should not jeopardize the structural performance of the TICP. The life-cycle cost analysis case study indicated that the TICP designs considered were not a cost-effective alternative to jointed plain concrete pavement, unless the construction costs for the cement layer are reduced.

WHAT IS THE BENEFIT?

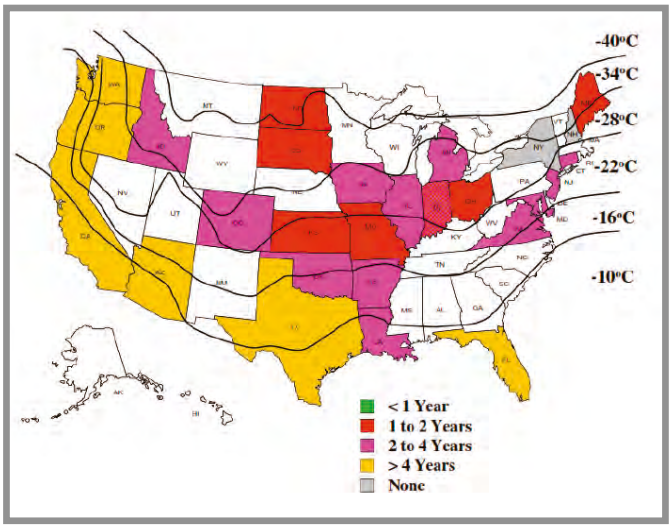
Although composite pavements have had success overseas, their use in the United States tailed off in the 1960s, and minimal research on design and construction practices has been conducted. Having updated guidelines based on direct experimental results rather than from models not calibrated for today's loads and tire configurations improves construction and design decisions. Understanding the life-cycle costs helps determine appropriate applications of composite pavements. This project led to research products that have immediate application for asphalt overlays on portland cement concrete pavements for both rehabilitation and new construction.

LEARN MORE

To view the complete report and other information regarding this pooled fund study:
www.pooledfund.org/Details/Study/376



Locations of asphalt concrete and portland cement concrete projects. Icon color indicates the percentage of transverse cracking: blue less than 16%; green 16-25%; yellow 26-40%; red more than 40%.



Time in years until reflective cracking occurs in asphalt concrete overlays of portland cement concrete pavements

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Research Results

Pavement

Optimizing the Performance of Cement Blends

Ternary blends of cementitious materials can enhance concrete performance, strength, and longevity

JANUARY 2015

Project Title:
Development of Performance Properties of Ternary Mixes, TPF-5(117)

Task Number: 0887

Start Date: March 28, 2005

Completion Date: May 31, 2014

Product Category: Improved technical standard, plan, or specification

Task Manager:
Joe Holland
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WHAT WAS THE NEED?

Pavement engineers throughout the United States have used waste materials—byproducts of other industrial processes—such as fly ash, silica fume, and blast furnace slag for many years to supplement portland cement in concrete production. These ternary blends of supplementary cementitious materials (SCM) can improve the durability, strength, and cost of pavements and structures, as well as offer environmental benefits. SCMs provide many advantages, but introducing them into a mixture can also cause performance issues if the combination of materials or proportions are not suitable for the particular use. Specifications to produce concrete mixtures that meet specific performance objectives have not been adequately captured. In addition, selecting the SCMs to use has become more complicated with the growing availability of slag cement and silica fume and the limited supply of fly ash in some markets.

WHAT WAS OUR GOAL?

The goal was to document the quantitative information needed to make sound engineering judgments when using ternary mixtures to enhance the performance and life-cycle costs of transportation pavements and structures.

Rigid pavement reconstruction using a ternary mixture on I-80 in Emigrant Gap

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WHAT DID WE DO?

Caltrans, as part of a pooled fund study lead by the Iowa Department of Transportation, evaluated how ternary blends can be used to improve the performance of concrete. This comprehensive project was spread over several stages. During the first phase, the researchers conducted laboratory experiments to study the influence of various proportions of cement, slag, silica fume, and fly ash on specific properties of mortar specimens and to locate ways to optimize the results. Based on the information collected, the second phase involved selecting a reasonable range of materials and dosages for use in laboratory concrete mixtures.

In the third phase, the participating states had on-site technical support for using ternary mixes in a local project. In California, an 11-mile section on I-80 from Emigrant Gap to Yuba Gap was reconstructed using a ternary mixture. A mobile concrete laboratory equipped for on-site cement and concrete testing was provided by the Federal Highway Administration to collect data and field observations.

WHAT WAS THE OUTCOME?

Ternary mixtures can be developed for any application and have a high probability of improving performance, lowering life-cycle costs, and reducing environmental impacts than pavements that do not incorporate SCM. However, each mixture—the type of cementitious materials and percentage—should be designed for the performance needs of the intended purpose rather than relying on a fixed prescriptive approach.

The California test section did not experience any difficulties with the materials during construction. After the first winter, some surface loss was observed on one section, which might have been caused by studded tires.

Concrete batch plant

WHAT IS THE BENEFIT?

Using SCMs in concrete production supports environmental and energy conservation as well as provides performance benefits. Cement blends use industrial byproducts otherwise destined for landfills. Incorporating these materials reduces the need to produce more portland cement and uses the energy already expended in the manufacturing process. When properly used, SCMs can dramatically improve the overall performance and lower the long-term cost of transportation pavements and concrete structures.

LEARN MORE

To view the complete report:
www.intrans.iastate.edu/research/documents/research-reports/ternary_final_w_cvr.pdf

Mobile research laboratory supporting the on-site project

Preparing specimens for testing

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Research Results

Developing Methods for Collecting Spatially Focused Travel Behavior

Localized travel surveys inform decisions on land use and urban infill projects

Planning/ Policy/ System Information

FEBRUARY 2014

Project Title:
Spatially Focused Travel Survey Data Collection and Analysis: Closing Data Gaps for Climate Change Policy

Task Number: 2243

Start Date: December 16, 2011

Completion Date: July 30, 2013

Product Category: Improved decision support tool

Task Manager:
Bob Justice
Associate Transportation Planner
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WHAT WAS THE NEED?

California Senate Bill (SB) 375—the Sustainable Communities and Climate Protection Act of 2008—requires that the state's metropolitan planning organizations develop strategies that integrate transportation, land use, and housing policies to reduce vehicle usage and greenhouse gas emissions. To help decision-makers estimate, model, and forecast the state's travel needs, the California Household Travel Survey is conducted every 10 years to collect information on travel behavior. These estimates are based on averaged travel behavior responses collected from metropolitan areas and larger regions. However, the current travel diary surveys provide limited information on the effect of small-area land use policies, such as infill development and transit-oriented land uses near stations. Understanding how the characteristics of these communities influence travel behavior is important to inform policies on integrating transportation and land use planning and bringing housing and job growth into transit-oriented, mixed-use, and compact communities.

WHAT WAS OUR GOAL?

The goal was to develop methods of collecting spatially focused travel data to improve policy and funding decisions regarding travel service, land use, and infrastructure enhancements.

Light rail in Pasadena
Source: Digital Media Pro/ Shutterstock.com

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Developing Methods for Collecting Spatially Focused Travel Behavior

Research Results

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Irvine Institute of Transportation Studies, conducted 300–600 travel diary surveys in neighborhoods near two rail transit corridors in Los Angeles—the subway Red Line and light rail Gold Line—to examine the effect of land use factors on reducing vehicle miles traveled (VMT) in small neighborhoods and assess whether these areas depart from the regional, averaged land-use-travel data. The corridors were chosen based on population density, job accessibility, concentration of local businesses, distance to employment sub-centers, and distance to transit. The study areas are approximately a half mile from center to edge, a size that corresponds to the scale of redevelopment opportunities, transit station development, and infill projects.

WHAT WAS THE OUTCOME?

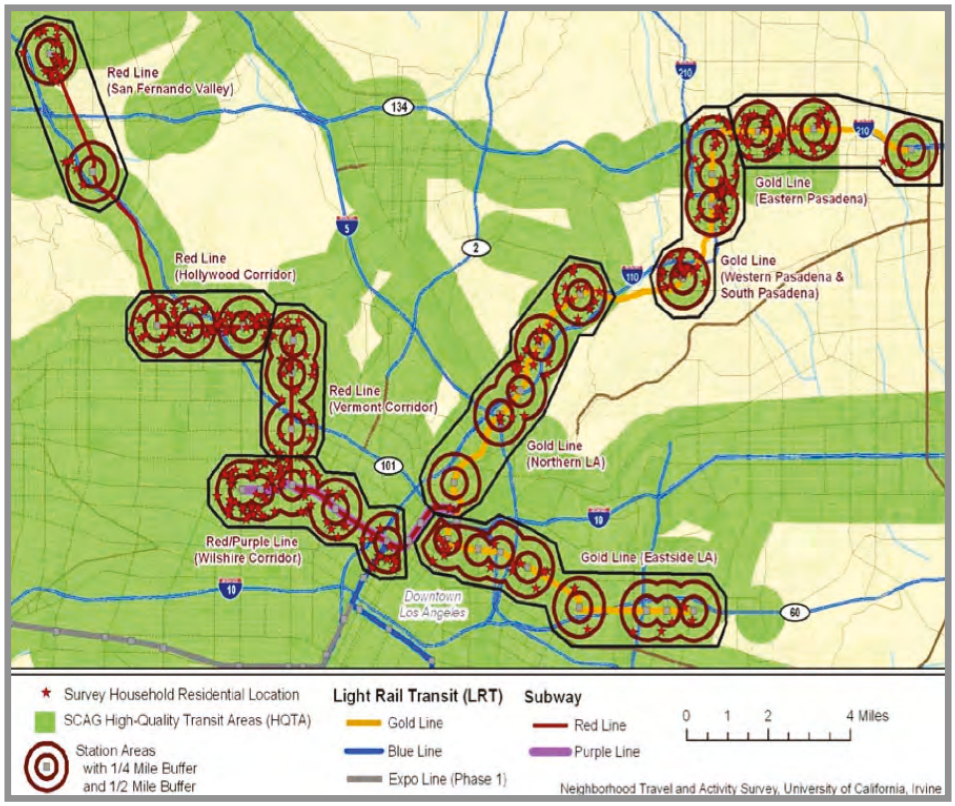
The methods developed advanced efforts toward low-cost, rapid travel data collection that can be used in before-and-after transportation program evaluations in the future. The survey responses suggested differences in walking, transit, and passenger vehicle travel behavior associated with residing in areas with different built environment, land use, and transit access characteristics. Based on the countywide sample, households in areas with higher employment accessibility tended to have more walking travel and lower VMT. Households within 1.5 miles of a rail transit station had more transit ridership, and this relationship was strongest for households within 0.5 miles of a rail transit station. Households within 0.5–1.0 miles of a station had more walking travel, while households with higher levels of transit service had lower household VMT.

WHAT IS THE BENEFIT?

This research pioneered methods to obtain spatially focused travel data to inform current debates about how land use influences vehicle miles of travel. The results expanded the understanding of land use and travel relationships and the importance of collecting localized data to help policymakers make more informed decisions regarding integrating transportation and land use planning in mixed-use, compact communities. Collecting data that focuses on local land use can help close the gap between travel data, knowledge, and policy.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2013/final_report_contract_65a0438_task_2243.pdf



Study areas and location of households who completed the travel diary survey

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Research Results

Improving Regional Mobility in California's Border Communities

A multi-agency initiative to improve the traveler experience to and from California and Mexico

Planning/ Policy/ System Information

DECEMBER 2014

Project Title:
California's Integrated Border Approach Strategy (CA-IBAS)

Task Number: 2622

Start Date: July 1, 2013

Completion Date: July 30, 2013

Product Category: New policy, rule, or regulation

Task Manager:
Christine Azevedo
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WHAT WAS THE NEED?

California shares a 200-mile border with Mexico, the state's largest trading partner. Yet the border's infrastructure does not support the current and future cross-border flow of people and goods, and congestion and long wait times are common. California communities on the U.S.–Mexico border need more flexible approaches to addressing the border-crossing experience, especially in light of changing economic, environmental, and security needs. The primary weakness in the current approach is a lack of a shared, integrated vision in terms of planning and funding among the various federal, state, and local agencies involved in mobility projects around California's border communities. These government agencies could increase the effectiveness of their investments by jointly addressing the issues and needs created by cross-border employment, housing, goods movement, and tourism.

WHAT WAS OUR GOAL?

The goal of this multiphase project was to develop an institutional framework to identify, prioritize, fund, and implement integrated mobility and security strategies for California's land ports of entry along the border with Mexico.

This modified sign marks the dates when the new pedestrian path to Mexico opens. Planning activities on one side of the border have implications for the other side.

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Improving Regional Mobility in California's Border Communities

WHAT DID WE DO?

Caltrans, in partnership with METRANS Transportation Center, developed the California Integrated Border Approach Strategy (CA-IBAS), a two-phased, multi-agency initiative to improve mobility and the traveler experience in California border communities resulting from pedestrian and vehicle (including commercial) flows to and from U.S.-Mexico border ports of entry. One of the objectives for Phase I was to define the challenges for implementing projects and identify best practices and approaches to joint planning and multi-agency coordination for project development, financing, and delivery. The researchers examined case studies of other communities that are adjacent to a land port of entry and have established collaborative structures among various agencies. The team pinpointed overlapping and complementary areas among the agencies involved in border-related mobility and security activities and assessed the strengths and weaknesses of the current models used to facilitate multi-agency coordination at California's border.

WHAT WAS THE OUTCOME?

The CA-IBAS focuses on the unique institutional needs related to mobility and service delivery near California's southern border. A principal challenge is siloed planning and funding of infrastructure development and project delivery due to the restricted missions of many of the border-serving agencies. The research provides an overview of agencies involved in issues surrounding California border communities, institutional structures that might be used to improve service delivery and funding, and financing options to support those institutional structures and multi-agency projects. This phase developed a framework in which border-related projects can be identified, developed, funded, and built. It also addressed the conflicting and overlapping goals between economic development, mobility, and environmental justice in border communities. Phase II of the CA-IBAS will explore potential responses.

The multi-agency initiative includes improving the pedestrian experience at the U.S.-Mexico border.

WHAT IS THE BENEFIT?

The CA-IBAS provides an opportunity for stakeholders involved in California's border-crossing communities to create a planning framework that shifts away from siloed planning and funding to an integrated, multi-agency approach that promotes project collaboration and coordination of funding strategies and priorities.

LEARN MORE

To view the complete report:
www.dot.ca.gov/dist11/departments/planning/pdfs/2014_CA_IBAS_Phase_1_Final_Report.pdf

California communities on the U.S.–Mexico border need more flexible approaches to addressing the border-crossing experience.

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Research Results

Estimating Bicycle and Pedestrian Activity

Promoting non-motorized travel is hampered by a lack of data and understanding the factors that influence it

Planning/ Policy/ System Information

DECEMBER 2014

Project Title:
Non-Motorized Travel: Analysis of the 2009 NHTS California Travel Survey Add-On Data

Task Number: 2200

Start Date: August 1, 2011

Completion Date: December 31, 2013

Product Category: New decision support tool, simulation, model, or algorithm; processed data/database

Task Manager:
Bob Justice
Associate Transportation Planner
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WHAT WAS THE NEED?

Walking and bicycling as modes of transportation, referred to as non-motorized transportation or active travel, offer personal health, economic, environmental, and equity benefits. Yet these modes represent a small share of all travel in the United States—less than 10% of all trips based on data from 2008. In comparison, other developed countries, as well as some cities in the United States, have significantly higher levels of walking and bicycling, suggesting that policy changes could increase the use of non-motorized travel.

Infrastructure decisions and investments are influenced by assessed usage and need. However, detailed estimates of bicycle and pedestrian activity are not available. The National Household Travel Survey (NHTS) is the main source of bicycle and pedestrian data, but it does not fully cover the state nor represent all geographies. It is important to know how much cyclists and pedestrians are using roadways to inform where investments in bicycle and pedestrian infrastructure are needed and to identify potentially dangerous locations to improve safety.

WHAT WAS THE GOAL?

The goal was to improve the quantitative understanding of non-motorized travel and the factors that influence it to better address the needs of pedestrians and bicyclists.

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WHAT DID WE DO?

Caltrans, in partnership with the University of California, Davis Sustainable Transportation Research Center, analyzed the results from the 2009 NHTS, focusing on the California Add-On survey that Caltrans funded regarding non-motorized travel. The data represents 18,000 residents in all 58 counties, with descriptive results showing who is walking and bicycling, how much, and for what purposes. Modeling results identified key factors associated with active travel, including environmental and individual characteristics.

This research estimated cyclist and pedestrian activity based on a combination of travel survey, census, land use, safety, and collision data. A spatial database for the state captures key features of the built environment using various data sources to incorporate population density, access to jobs, and street connectivity. This task included basic descriptive analysis of neighborhood characteristics associated with higher levels of pedestrian and bicycle activity.

WHAT WAS THE OUTCOME?

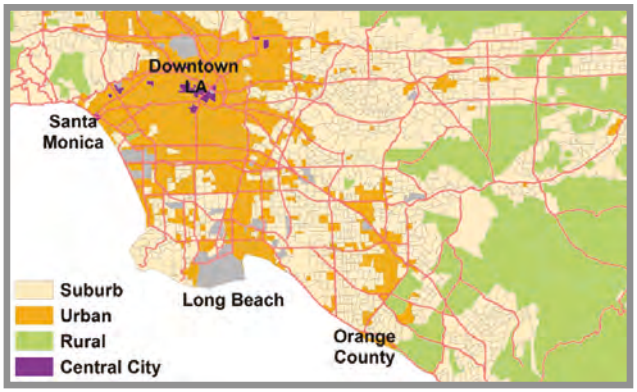
The research developed a new method of estimating pedestrian and cyclist activity levels at a more granular geographic scale. Econometric techniques were used to examine the effect of individual and environmental characteristics on non-motorized behavior. This data provides a better understanding of non-motorized travel behavior throughout the state.

WHAT IS THE BENEFIT?

Understanding the patterns of biking and walking and the factors that influence individuals is critical for creating effective policies to promote non-motorized travel. Having more robust data provides information on which roads are most heavily used by cyclists and pedestrians and helps prioritize infrastructure needs and investments. The results will contribute to the development of regional transportation plans and local bicycle and pedestrian plans and encourage the growth of non-motorized travel.

LEARN MORE

To view the complete report:
www.dot.ca.gov/hq/tpp/offices/ocp/ATLC/documents/9_Estimating_Total_Miles_Walked_and_Biked-Handy.pdf



The study classified areas into neighborhood types based on density and the characteristics of the built environment.

Results by Neighborhood Type Based on National and California Travel Surveys

Neighborhood Type	Mean Miles Walked per Road Mile		Mean Miles Biked per Road Mile	
	NHTS*	CHTS**	NHTS	CHTS
Central City	922	1,412	115	379
Urban	224	246	85	115
Suburb	92	65	33	47
Rural	34	22	14	13
	Mean Annual Accidents per Million Miles Walked on a Weekday		Mean Annual Accidents per Million Miles Biked on a Weekday	
	NHTS	CHTS	NHTS	CHTS
Central City	98	64	2,627	794
Urban	122	112	1,033	767
Suburb	133	189	837	582
Rural	199	327	899	899

* 2009 National Household Travel Survey
** 2010–12 California Household Travel Survey

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Research Results

Planning/ Policy/ System Information

Strategies to Reduce Greenhouse Gas Emissions for Interregional Travel

Improving system efficiency and lowering vehicle miles traveled between regions

FEBRUARY 2015

Project Title:
Near-Term Transportation Energy and Climate Change Strategies: Interregional Transportation Related Greenhouse Gas Emissions Reduction Strategies

Task Number: 2387

Start Date: March 1, 2012

Completion Date: December 31, 2013

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

Task Manager:
Patrick Tyner
Associate Transportation Planner
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WHAT WAS THE NEED?

Caltrans is working to address climate change factors in its operations and policies. California's Global Warming Solution Act of 2006, the nation's first global warming legislation, requires the state to decrease greenhouse gas (GHG) emissions to 1990 levels by 2020. California then passed Senate Bill (SB) 375, the Sustainable Communities and Climate Protection Act in 2008, another landmark legislation that calls for Metropolitan Planning Organizations (MPO) to develop strategies to reduce vehicular travel by incorporating land-use change scenarios. To address the transportation sector's role in GHG emissions, SB 391 requires Caltrans to update the California Transportation Plan by December 31, 2015, and every five years thereafter, to identify the statewide integrated multimodal transportation system needed to meet the mandated GHG emission reductions of 80% below 1990 levels by 2050.

A key component of the California Transportation Plan is to identify various regional and interregional GHG reduction strategies. However, data regarding vehicle miles traveled between urban centers is not as plentiful as in within urban areas. In addition, SB 375 excludes interregional travel—trips between or through metropolitan areas—in its planning mandate, therefore MPOs do not need to measure or address GHG emissions from interregional travel in their strategies. Caltrans needed an interregional strategy framework to address this data gap and improve system efficiency and lower vehicle miles traveled to reduce GHG emissions resulting from interregional travel.

WHAT WAS THE GOAL?

The goal was to provide Caltrans with tools to plan and prioritize the GHG emission reduction strategies for interregional travel on which California should focus.

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Strategies to Reduce Greenhouse Gas Emissions for Interregional Travel

Research Results

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Berkeley Transportation Sustainability Research Center, interviewed representatives from 14 regional planning organizations throughout California to learn about their work and identify and develop strategies to reduce GHG emissions. The interviews addressed interregional travel characteristics, challenges and opportunities, future goals, and lessons learned, primarily related to transportation system operational efficiency and freight planning.

In addition, a comprehensive literature review was conducted on 48 topics, including system efficiency, behavioral change, and strategies for reducing vehicle miles traveled, to understand and evaluate trends in transportation-climate issues. The goal was to help prioritize which GHG emission reduction strategies to focus on, understand the potential magnitude of emissions reduction from strategies where data is available, develop a level of confidence for various strategies, and gauge the social and political acceptability of strategies.

WHAT WAS THE OUTCOME?

The results of the MPO expert interviews on the technical and political feasibility of various interregional transportation strategies for GHG emission reduction can be used for post-processing the California statewide travel demand model. The study also summarized the existing literature on the contributing factors to reduce vehicle miles traveled, such as transportation and land use coordination, transportation alternatives, pricing system use, mode shift, and public awareness.

WHAT IS THE BENEFIT?

Caltrans has a better understanding of the trends in transportation-climate issues, emerging opportunities for sustainable operations and energy infrastructure, the uncertainties and obstacles that regions and the state face, and which interregional GHG emission reduction strategies are feasible in light of technology and budgetary constraints. California is in the forefront of addressing climate change, and the results of this work could potentially assist other state and regional departments of transportation who have yet to develop their own strategies to address GHG emissions in their operations, plans, and policies.

LEARN MORE

To view the complete report:
http://tsrc.berkeley.edu/node/766

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Research Results

Monitoring Ethanol Fuel Usage

New system that measures ethanol consumption helps support alternative fuel program

Planning/ Policy/ System Information

JANUARY 2015

Project Title:
Research and Development of an E85 Alternative Fuel Fleet Monitoring System

Task Number: 1919

Start Date: September 8, 2010

Completion Date: March 31, 2014

Product Category: New tool or equipment

Task Manager:
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Transportation Engineer, Electrical
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WHAT WAS THE NEED?

Caltrans has been investing in a variety of alternative-fueled vehicles as part of its fleet to reduce emissions and reliance on conventional gasoline. Ethanol (E85)-compatible vehicles are part of this program. However, it has been difficult to determine how much ethanol fuel these vehicles are actually using because of their flexible-fuel capability of running on E85, gasoline, or a combination of both. Traditional methods of matching refueling records with vehicles have not provided enough insight regarding the activity of specific vehicles. To gain a more thorough understanding of alternative-fuel consumption requires a specialized telematics system to monitor vehicle activity and usage patterns. This project has been carried out in three phases. In the first phase, a prototype system was developed and tested on 10 vehicles and extended into a second phase due to time and money. This report documents the final phase, which consisted of a comprehensive evaluation to develop a deployment plan for additional vehicles and system expansion.

WHAT WAS OUR GOAL?

The goal was to develop, implement, and evaluate a system that can monitor alternative fuel consumption in the Caltrans fleet and make the data accessible to managers and supervisors.

Vehicles were stimultaneously integrated with telematics to improve installation efficiency.

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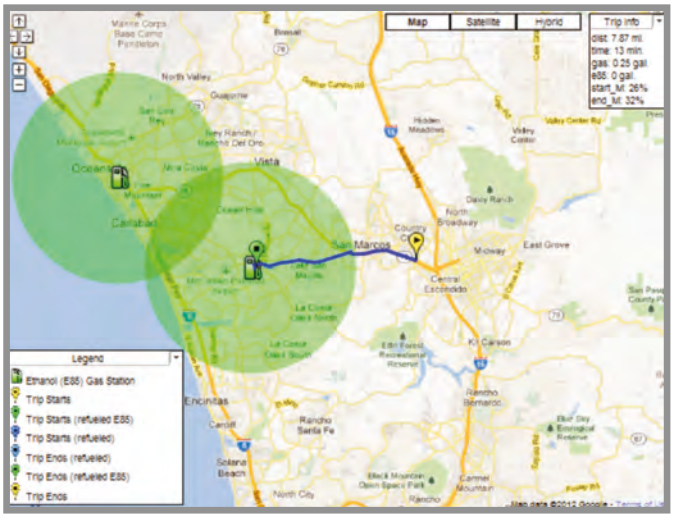
WHAT DID WE DO?

Caltrans, in partnership with the University California, Riverside Center for Environmental Research and Technology, developed a system that can remotely monitor alternative fuel usage, fuel mixture, fueling locations and times, and vehicle activity—location, miles traveled, and speed. The system's base architecture was developed in a previous pilot consisting of 10 vehicles and expanded in this phase to include 100 vehicles dispersed among four districts.

The architecture requires an onboard vehicle telematics system capable of tracking vehicles using position information from a GPS receiver. A microcontroller communicates with the system via Wi-Fi or a cellular network, sending information on vehicle activity and fuel consumption. The microcontroller interfaces with the vehicle through the OBD-II data port. The system also includes a data repository and server for receiving and storing the transmitted data and a web-based user interface for remotely reviewing the information in an accessible manner.

WHAT WAS THE OUTCOME?

The monitoring system enables staff, managers, and fleet operators to quantify fuel usage in terms of vehicle activity. When a trip starts, the system logs the real-time engine data along with the vehicle's GPS position. At the end of the trip, the information is transmitted to a computer server via a cellular connection or Wi-Fi transmitter located within the motor pool parking garages at District offices.



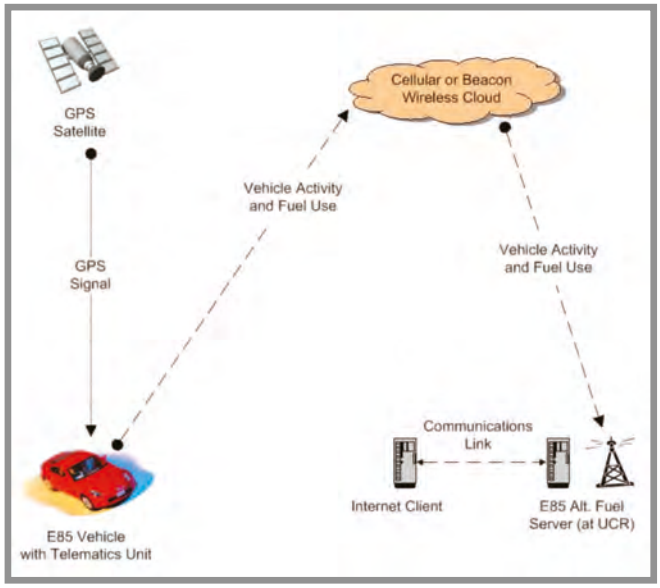
Mapping function shows trip progress and refueling.

WHAT IS THE BENEFIT?

The fuel monitoring system provides a foundation for a future deployment of a commercial-scale system. The onboard functionality informs drivers of the fuel composition, refueling locations, and emissions savings. The system promotes expanding the use of E85 vehicles because drivers and supervisors can observe and track usage and quantify the cost and environmental benefits of using alternative fuels.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2015/final_report_task_1919.pdf



E-85 fuel usage monitoring architecture with combined cellular and Wi-Fi communications

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Research Results

Estimating the Transportation Impact of Smart-Growth Land-Use Projects

New methodology broadens trip-generation analysis to include non-vehicular modes of transportation for smart-growth developments

Planning/ Policy/ System Information

NOVEMBER 2014

Project Title:
California Smart-Growth Trip-Generation Rates Study

Task Number: 1940

Start Date: November 3, 2008

Completion Date: March 31, 2014

Product Category: New decision-support model and tool

Task Manager:
Scott Williams
Associate Transportation Planner
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WHAT WAS THE NEED?

The California Environmental Quality Act and other state, federal, and local laws require that the transportation-related impacts of proposed land-use projects be identified, analyzed, and mitigated. The first step in preparing a transportation impact analysis is to estimate the number of trips by cars, trucks, and other modes of travel that might result from the project. Practitioners typically use trip-generation rates published by the Institute of Transportation Engineers (ITE), a national professional organization.

The ITE trip-generation rates are based on data collected primarily at suburban sites with minimal transit, bicycle, or pedestrian facilities and do not address other modes of transit. Recent studies indicate that the ITE data overestimates the number of vehicle trips for projects located in urban areas near transit and within walking distance of other land uses. By following existing guidelines, transportation engineers often over-prescribe automobile infrastructure in smart-growth locations, resulting in wider roadways, more turning lanes, and more parking spaces than necessary. In addition, adequate pedestrian, bicycle, or public transit facilities that might improve conditions for traveling are not recommended.

A commonly accepted methodology for estimating multimodal trip-generation rates associated with smart-growth projects is needed so that practitioners can more accurately estimate a development's traffic impact and recommend the appropriate transportation mitigations, including walking, biking, and transit facilities.

City Center, Oakland, CA

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Estimating the Transportation Impact of Smart-Growth Land-Use Projects

Research Results

WHAT WAS OUR GOAL?

The goal was to create a methodology tool to estimate trip-generation rates of vehicle, public transit, and non-motorized trips associated with smart-growth and infill projects, such as those located in downtowns and other high-density, mixed-use areas.

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Davis, collected trip-generation data at 30 smart-growth sites in California and used this information, along with trip-generation data from other studies, to develop a spread-sheet tool to estimate travel associated with proposed urban infill and other smart-growth land-use projects. The method adjusts the ITE rates based on the characteristics of the development project and its surrounding context.

WHAT WAS THE OUTCOME?

On average, the ITE rates estimated vehicle trips 2.3 times higher than actual counts during the morning peak hour, and 2.4 times higher during the afternoon peak travel hour. The new tool provides a more accurate estimation of vehicle trips associated with urban infill projects and the degree of vehicle-related mitigations, such as wider roads, as well as improving the estimation of appropriate facilities and services for walking, bicycling, and transit use.

Future research will address how to incorporate this methodology in the ITE Trip Generation Manual used by most traffic engineers.

WHAT IS THE BENEFIT?

Expanding the methodology for estimating trip-generation rates to include all modes of transport—walking, bicycling, public transit, and driving—promotes smart growth and supports sustainable transportation and land-use systems. Providing the appropriate infrastructure and a more conducive environment for multimodal transportation reduces vehicular traffic, encourages walking and biking, and boosts the economic vitality of urban infill developments. The adjusted trip-generation rates guide transportation engineers to recommend facilities that improve the conditions for pedestrian, bicycle, or public transit travel.

LEARN MORE

To view the complete report and spreadsheet tool:
http://downloads.ice.ucdavis.edu/ultrans/smartgrowthtripgen

Collecting trip-generation data through intercept surveys

ITE tends to emphasize measures to meet motorists' needs, which are often not appropriate for pedestrians, bike riders, and transit users.

Smart-growth sites need to take different modes of transportation into account.

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Research Results

Measuring the Air Quality Gains of HOV Lanes

Managing lane usage is an effective method for reducing emissions

Planning/ Policy/ System Information

FEBRUARY 2015

Project Title:
Deployment of Prior HOV Lanes Research Results in Developing Analysis Tools for New Managed Lanes Projects

Task Number: 2329

Start Date: April 1, 2012

Completion Date: March 31, 2014

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

Task Manager:
Bob Justice
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WHAT WAS THE NEED?

Managed lanes—high-occupancy vehicle (HOV) lanes, express lanes, and high-occupancy toll (HOT) lanes—are an integral part of California's highway system, with over 1,500 lane miles either in operation or under construction and hundreds of more lane miles proposed. The goals of HOV lanes are to relieve congestion, conserve fuel, and improve the air quality in metropolitan areas. It is necessary to ensure that existing, converted, and new managed lane projects are meeting the purpose of improving air quality. Based on the results from previous tasks, this project developed a modeling toolset to provide reliable estimates of the air quality impacts of HOV lanes.

WHAT WAS THE GOAL?

The goal was to enhance analysis tools developed in previous tasks to evaluate the emission impacts of different types of managed lanes.

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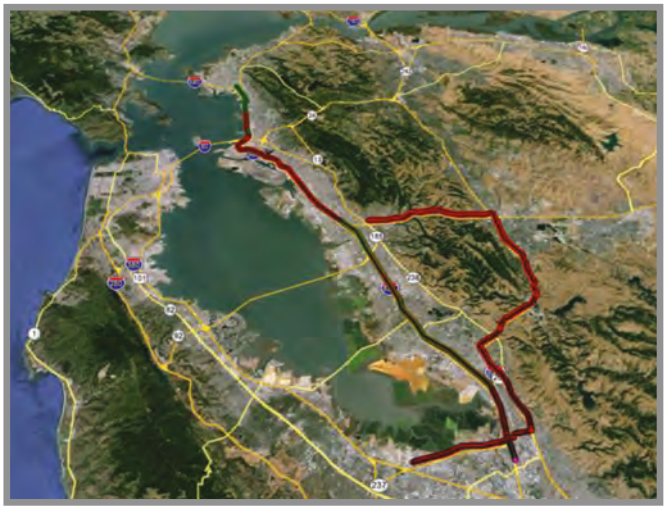
WHAT DID WE DO?

Caltrans, in partnership with the University of California, Riverside Center for Environmental Research and Technology, had previously completed research on the effectiveness of HOV lanes in improving air quality. As part of that study, the researchers had developed analysis tools to evaluate the emission impact of limited-access HOV lanes, which are commonly found in Southern California. This project expanded the capability of the developed tools to incorporate vehicle activity data collection, traffic simulation, and emission modeling to enable evaluation of other types of managed lanes, including continuous-access HOV lanes, generally used in Northern California, and HOT lanes. The researchers defined the mandatory and optional data inputs as well as the corresponding outputs. They then implemented the analysis steps and data flow in Microsoft Excel.

WHAT WAS THE OUTCOME?

The analysis tools are compatible with California's EMission FACtors (EMFAC) model, using a spreadsheet platform that is easy to use by Caltrans technical staff. The deployment was supported with a user guide and training conducted to ensure effective knowledge and technology transfer.



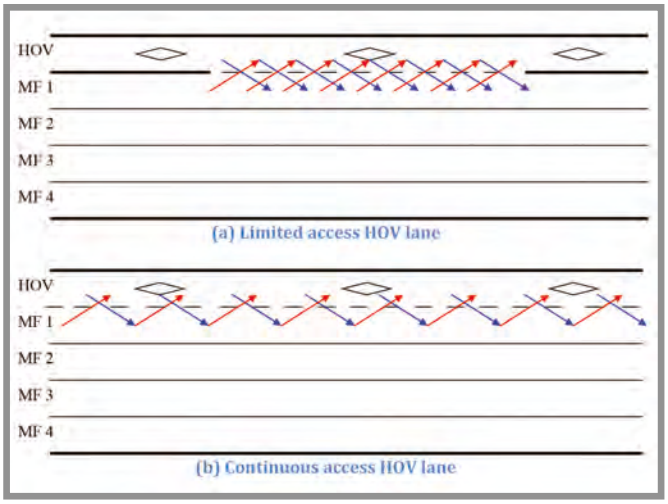
Data collection sites in Northern California

WHAT IS THE BENEFIT?

HOV lanes produce less pollutant emissions per lane as compared to adjacent general-purpose lanes. The enhanced tools help quantify the air quality benefits of the various types of HOV lanes, allowing Caltrans to set appropriate operation policies based on sound scientific findings. Caltrans can also use these measurements to quickly prepare environmental review documents to ensure timely delivery of managed lane projects.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2014/final_report_task_2329.pdf



Configurations of HOV lanes in California

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Research Results

Quantifying Construction Equipment Emissions

New emissions model provides more thorough information to address regulations

Planning/ Policy/ System Information

NOVEMBER 2014

Project Title:
Developing a Model to Quantify Emissions from Heavy-Duty Construction Equipment

Task Number: 2330

Start Date: March 1, 2012

Completion Date: April 30, 2014

Product Category: New decision support tool and model; improved technical standard, plan, or specification

Task Manager:
Patrick Tyner
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WHAT WAS THE NEED?

Gaseous and particulate emissions from construction engines are an important portion of California's total air pollutants and are gaining increasing regulatory attention. It is necessary to quantify nitrogen oxides and particulate matter to inventory the contribution of construction equipment, such as used by Caltrans, to atmospheric loadings, particularly for those projects in maintenance areas or where air pollution levels consistently exceed the national ambient air quality standards.

Part of the justification for air emissions regulations in California is based on California Air Resources Board (CARB) estimates of emissions from construction equipment. Regulations requiring retrofitting or replacing older equipment to reduce emissions had been enacted, but were on hold. In response, Caltrans determined the need to develop an emissions model to quantify off-road fleet emissions at a regional level and at specific job sites. Since completion of the task, the regulations were amended to include performance requirements and remove mandated retrofitting, but letting it remain as a compliance option if an agency decides it is a less expensive option. As a result, the hold has been lifted. Through the model's analysis capability, Caltrans can better estimate the emissions factors of its construction practices, evaluate equipment options, and ensure compliance with CARB regulations.

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WHAT WAS THE GOAL?

The goal was to quantify certain air pollutants that occur during the use of heavy-duty construction equipment activity.

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Riverside Center for Environmental Research & Technology, measured the emissions, fuel economy, and activity of various off-road construction equipment under normal operations in the field. The researchers collected the portable emission measurement system (PEMS) and portable activity measurement system (PAMS) data to develop an Excel model that helps determine the correlations between the measured emissions and the engine operation parameters. These correlations formed the basis of the emissions model.

WHAT WAS THE OUTCOME?

The researchers developed an Excel-based model to estimate the off-road emissions of the major pieces of construction equipment employed in Caltrans projects. As emissions and activity data become available for additional equipment types, the Excel model can be modified to expand its applicability and provide a more formal basis for regulatory development.

WHAT IS THE BENEFIT?

Prior to this effort, no model was mutually accepted by Caltrans and the regulatory agencies to use for estimating construction emissions or developing appropriate regulations, due in part to a lack of emissions data from construction equipment under in-use operating conditions. Not having substantiated data and a scientific basis for regulation has resulted in legal cases and other obstacles that could potentially delay or inhibit important transportation projects. Establishing regulations based on sound science enhances the environmental process associated with implementing new construction projects.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2014/final_report_task_2330.pdf

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Research Results

Dispersion Patterns of Mobile Source Air Toxics Near Highways

Understanding how MSAT emissions behave

Planning/ Policy/ System Information

JANUARY 2015

Project Title:
Mobile Source Air Toxics (MSAT) from Major Highways, TPF-5(170)

Task Number: 1651

Start Date: March 1, 2008

Completion Date: December 31, 2013

Product Category: Improved technical standard, plan, or specification

Task Manager:
Patrick Tyner
Associate Transportation Planner
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WHAT WAS THE NEED?

In 2002, the Sierra Club challenged the Federal Highway Administration (FHWA) and the Nevada Department of Transportation's environmental report concerning the proposed widening of U.S. 95 in Las Vegas, Nevada, and the assessed impact of mobile source air toxics (MSAT) from the project. MSATs are compounds emitted from highway vehicles that are known or suspected to cause cancer or other serious health and environmental effects. MSATs also contribute to precursor emissions that react to form secondary pollutants. As part of the lawsuit settlement, the FHWA agreed to undertake a study to evaluate MSAT emissions and their dispersion patterns. The FHWA contacted all 50 states regarding participating in this research study. Nevada and Michigan volunteered to support a monitoring site, while a number of other states, including California, provided funding for the project.

WHAT WAS OUR GOAL?

The goal was to enhance Caltrans' ability to better understand and assess a wider range of air emission impacts near state highways.

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Dispersion Patterns of Mobile Source Air Toxics Near Highways

Research Results

WHAT DID WE DO?

The FHWA, in conjunction with a consortium of federal agencies and state departments of transportation, evaluated MSATs at two sites, one in Las Vegas along I-15 and the other in Detroit on I-96, areas that differ greatly in geography and climate. To conduct the study, the FHWA outlined a detailed monitoring protocol to establish a uniform approach for measuring the impact and behavior of particulate matter with aerodynamic diameter less than 2.5 microns and MSAT compounds near highways. The protocol was peer-reviewed by other federal agencies, state environmental and transportation agencies, the Sierra Club, and academic institutions. The objective was to determine MSAT concentrations and variations as a function of distance from the highway and the effect of highway traffic flows and meteorological conditions. Data was gathered by placing instruments 10, 100, and 300 meters from the roadway. Researchers also measured wind speed, wind direction, and roadway characteristics, such as traffic counts, speed, and vehicle types.

WHAT WAS THE OUTCOME?

The study identified modeling techniques to collect MSAT data and confronted some of the challenges that researchers have to overcome and adapt to, both technically and programmatically. Preliminary study results indicate that highway vehicle emissions impact near-road air quality, and concentrations tend to decrease further away from the road. Additional analysis is needed to more accurately quantify the effect of wind speed and other non-highway sources, such as nearby parking lots and traffic from adjacent roadways. For both study sites, concentration gradients for gaseous pollutants associated with the distance from the roadway and higher pollutant concentrations with higher traffic volumes were observed.

WHAT IS THE BENEFIT?

The FHWA study enhanced the understanding of MSAT emissions associated with major highway facilities. During the development of both new and upgraded highway projects, it is important to understand how these emissions impact the surrounding communities. This information helps to better address the concerns of those living near highways and mitigate potential health hazards. The research identified the process of collecting MSAT data in different geographic environments, which Caltrans can apply in the analysis of future projects to make more informed decisions. Ultimately, the people of California gain by having a transportation system that takes both sustainability and public health concerns into account.

LEARN MORE

To view the pooled fund reports:
www.pooledfund.org/Details/Study/397

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Research Results

Mobile Terrestrial Laser Scanning for Surveying

Mobile surveying equipment facilitates rapid project delivery and enhances safety of field personnel

Right of Way and Land Surveys

JANUARY 2015

Project Title:
Mobile Terrestrial Laser Scanning Workflow Development, Technical Support and Evaluation

Task Number: 2517

Start Date: October 1, 2012

Completion Date: June 14, 2014

Product Category: New manual, handbook, guidelines, or training; improved business practice, procedure, or process

Task Manager:
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WHAT WAS THE NEED?

Caltrans requires survey grade measurements for various projects, such as bridge structures, pavements, major accident investigations, and roadside assets. Typically, when performing a survey, field personnel are exposed to high-speed traffic, often with no barrier or protection. Mobile terrestrial laser scanning (MTLS) is a relatively new technology that enables surveyors to work safely from a vehicle. MTLS also provides many efficiency and technological improvements. The system produces accurate and precise geospatial data at or near highway speeds, enabling surveyors to collect many miles of roadway in a single day, accelerating project delivery. Users can then work with the broad range of data collected while in the office, removing the need to return to the field for measurements. For these reasons, Caltrans purchased an MTLS system in 2012, which has been used for many northern California projects. After this initial pilot, workflow practices and training are needed to properly integrate the technology into current Caltrans projects, as well as a cost-benefit review to determine whether to purchase another MTLS system or use the existing one throughout California.

WHAT WAS OUR GOAL?

The goal was to develop standards and specifications, best practices, training, and a cost-benefit analysis to effectively integrate MTLS into the Caltrans workflow.

Point cloud image of the new San Francisco-Oakland Bay Bridge

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WHAT DID WE DO?

Caltrans, in partnership with the University of California, Davis Advanced Highway Maintenance & Construction Technology Research Center, explored how the MTLS technology could be used in various projects in the field. The researchers documented the case studies and results and identified the level of operation and safety achieved from using MTLS. The researchers also provided recommended best practices and standards on MTLS surveying, developed training materials, and conducted training sessions for surveyors on how to use the MTLS equipment and software.

WHAT WAS THE OUTCOME?

The Caltrans MTLS vehicle has been used for over 90 projects in eight different Caltrans districts, mostly for producing pavement digital terrain models. The projects included rural and urban multilane divided highways, rural undivided highways, bridges, and tunnels. Northern California districts 1, 2, 3, and 4 were the primary users and performed additional work for Caltrans districts 6, 9, 10, and 11. After user training, the MTLS system will be deployed to central and southern California during the 2015 winter season.

Photo log image collected with the MTLS scanner system at Altamont Pass on Highway 580

WHAT IS THE BENEFIT?

Mobile surveying improves worker safety and decreases the lead time from data requested to data delivery, survey time and cost, the number of return site visits to collect additional data, and travel delay for motorists. MTLS provides high-resolution 3D data that improves visualization and enhances project design, facilitating decision-making. Collecting and processing data safely, efficiently, and accurately saves money while significantly reducing work crews' exposure to direct traffic, minimizing injuries, injury-related costs, and roadway congestion for traveling motorists.

LEARN MORE

To view the complete report:
http://ahmct.ucdavis.edu/pdf/UCD-ARR-14-06-14-01.pdf

Caltrans Trimble MX8 MTLS vehichle

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Research Results

Telecommunications Training for Rural Engineers and Technicians

Hands-on courses provide skills for designing and maintaining reliable transportation systems in rural communities

Rural

DECEMBER 2014

Project Title:
Professional Capacity Building for Communication Systems Phase II

Task Number: 1746

Start Date: June, 27, 2011

Completion Date: October, 31, 2013

Product Category: New training

Task Manager:
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WHAT WAS THE NEED?

As various telecommunications technologies, like fiber optics, become more viable for remote locations, engineers and technicians in rural areas need to get familiar with the advances in transportation communication systems and the particular challenges that rural transportation communications face. Many engineers and technicians have relatively little experience with the myriad of technologies for designing and maintaining reliable and robust communication networks for rural Intelligent Transportation Systems (ITS) field equipment. Understanding which communication technologies exist, the terminology and concepts, how the technology can be used effectively, and the pros and cons of various options, helps engineers distinguish what vendors are offering and whether the offerings are realistic.

WHAT WAS OUR GOAL?

The goal was to develop and conduct specialized hands-on telecommunications training for rural engineers and technicians to provide the skills needed for designing and maintaining reliable and robust communication networks for rural ITS field equipment.

Fiber optics training course

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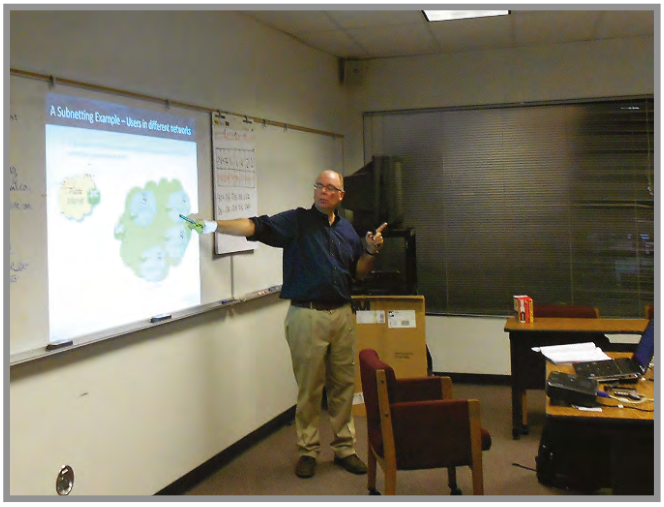
Telecommunications Training for Rural Engineers and Technicians

WHAT DID WE DO?

Caltrans, in partnership with the Montana State University Western Transportation Institute, researched, developed, and delivered a comprehensive training curriculum to expand the professional capacity of rural ITS engineers and technicians. Led by subject matter experts, the training provided hands-on practical education centered on understanding the various communication technologies available and how to best select and implement these technologies, particularly in a rural environment.

One course focused on installing, maintaining, testing, and troubleshooting fiber-optic networks. It addressed available product options, typical specifications for such products, and the advantages and disadvantages. The other course featured the fundamentals of Internet Protocol (IP) networking.



Hands-on Ethernet and TCP/IP fundamentals training course

WHAT WAS THE OUTCOME?

Participants came from seven Caltrans districts to address rural transportation challenges. In the context of real-world and immediate concerns, they became familiar with the terminology and concepts needed to communicate with vendors, colleagues, and other professionals to minimize misunderstandings. The participants provided positive feedback in gaining the knowledge and skills needed to implement communications systems and troubleshoot IP networking. During the training, attendees also had the opportunity to meet other ITS engineers and learn what kind of equipment is being used and how it is deployed in similar areas. Additional specialized training in other ITS areas by subject matter experts is recommended for the next phase of this project.

WHAT IS THE BENEFIT?

If engineers do not have fundamental knowledge of communication technologies available in the market, they cannot make informed decisions when assessing vendors for reliable ITS communications systems. After this training, Caltrans engineers and technicians who attended can better assess vendors as well as design, implement, and maintain reliable and robust ITS communication systems in rural and remote areas.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2013/final_report_task_1746.pdf

For more information about the training, visit:
www.westernstates.org/projects/PCB/default.html

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Research Results

Seismically Testing Backfilled Mechanically Stabilized Earth Walls

MSE retaining walls with recycled tire-derived backfill can sustain strong seismic shaking

Seismic

FEBRUARY 2015

Project Title:
Seismic Responses of Mechanically Stabilized Earth Walls Using Accelerated Alternative Backfill Materials with Recycled Tire Shreds and Lightweight Aggregates

Task Number: 2416

Start Date: May 16, 2012

Completion Date: July 16, 2013

Product Category: New technical standards and specifications

Task Manager:
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Research Contract Manager
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WHAT WAS THE NEED?

To repair and replace our aging highway and bridge infrastructure with the least impact to the motoring public, accelerated construction techniques are gaining popularity. Mechanically stabilized earth (MSE) walls is one technique that is widely used in retaining embankments in highway systems, because in certain situations they are easier to construct and more economical than conventional reinforced concrete retaining walls. To accelerate construction, alternative materials, such as tire-derived aggregates and lightweight aggregates, are increasingly used as backfill for the retaining walls. Lightweight aggregates consist of clay or shale expanded in a kiln. Tire-derived aggregates are pieces of shredded waste tires, which offer the added benefit of reusing materials that would otherwise be disposed of in landfills or stockpiled. Generally, MSE walls have performed well during past major earthquakes. However, they have not yet been fully tested with the alternative aggregate backfill under seismic conditions.

WHAT WAS OUR GOAL?

The goal was to investigate the seismic performances of mechanically stabilized earth walls with tire-derived or lightweight aggregates as backfill and provide design and construction recommendations for seismic regions.

Tired-derived and lightweight aggregates

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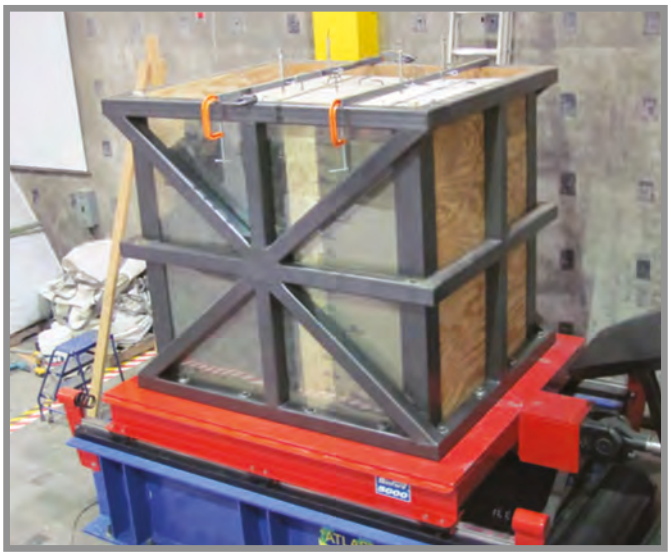
Seismically Testing Backfilled Mechanically Stabilized Earth Walls

Research Results

WHAT DID WE DO?

Caltrans, in partnership with the California State University, Fresno Department of Civil and Geomatics Engineering, investigated the seismic performance of MSE walls with tire-derived aggregates and lightweight aggregates as backfill. The researchers tested a 1.5 meters x 1.5 meters x 1.3 meters deep MSE model wall on a one-dimensional shake table. They simulated a full-scale earthquake, comparable to Loma Prieta or Northridge, and sinusoidal sweep-frequency motions (0.2 to 6.0 Hz). A flexible boundary condition was incorporated in the tests, and seismic design was used to construct the internal stability of the MSE wall. The researchers also developed a model using Plaxis geotechnical software to replicate the experimental studies. The numerical model verified the validity of using the spring-supported boundary condition in the shake table testing. The comparison between the numerical and the experimental results warrants further studies to improve the material characteristics and modeling techniques.



Shake table test of an MSE wall

WHAT WAS THE OUTCOME?

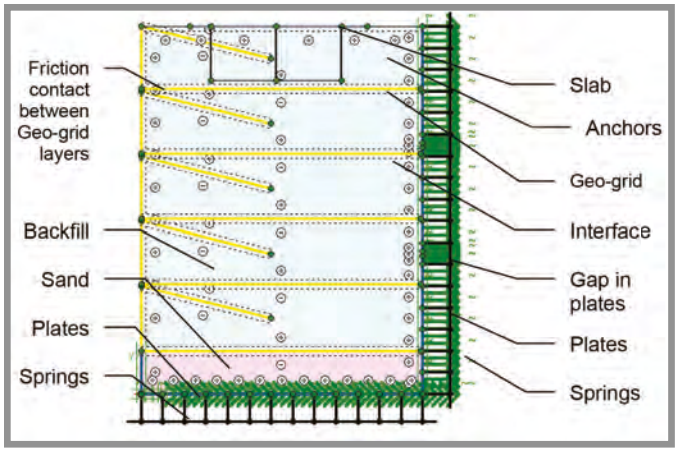
When properly designed, MSE walls with tire-derived backfill can sustain strong seismic shaking without excessive deformation and lateral spreading. Based on the results, tire-derived aggregates perform better in seismic regions than lightweight aggregates. The Federal Highway Administration's seismic design methodology for MSE walls with traditional backfill might be suitable for these alternative backfills.

WHAT IS THE BENEFIT?

Accelerated construction techniques have proven benefits, including minimizing traffic disruption, improved work zone safety, and reduced on-site environmental impacts. MSE retaining walls using recycled tire-derived aggregates as backfill provide an accelerated solution that is environmentally friendly and can reduce costs and save time.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2013/final_report_65a0449.pdf



Geometry of the MSE model

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Research Results

Seismic

Improved Bridge Columns for Seismic Areas

Advanced materials in precast bridge columns speed up construction time, improve resiliency, and reduce post-earthquake damage

DECEMBER 2014

Project Title:
Next Generation of Bridge Columns for Accelerated Bridge Construction in High Seismic Zones

Task Number: 2176

Start Date: June 30, 2010

Completion Date: December 31, 2013

Product Category: New technical standards and specifications

Task Manager:
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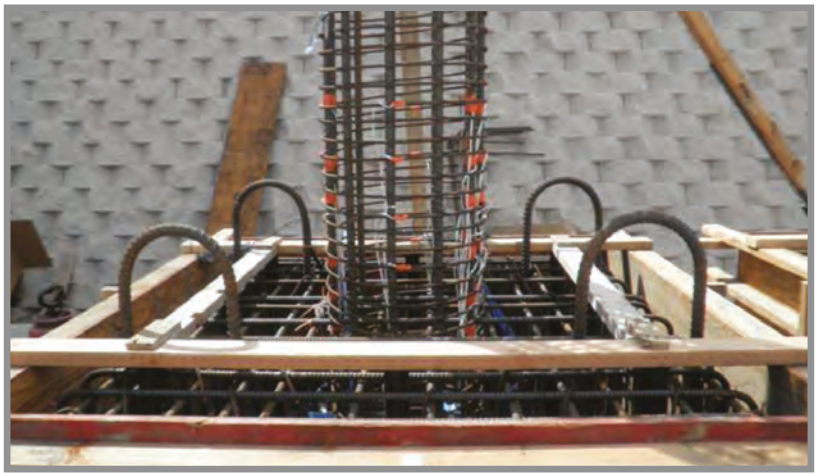
WHAT WAS THE NEED?

The majority of bridges and their components in California are cast in place, which is a time-consuming construction method that can take months. To shorten onsite construction time, an alternate approach is to implement Accelerated Bridge Construction (ABC), a technique that uses prefabricated structural elements that can be rapidly assembled at the construction site. ABC offers many other advantages, such as less impact on traffic, improved work zone safety, more durable bridges because of the use of quality precast members, and potentially lower overall cost. ABC is already a routine technique for some bridge components, such as bent caps, but precast columns have been rarely applied in moderate and high seismic zones because of the absence of performance data and lack of confidence in the connections.

WHAT WAS OUR GOAL?

The goal was to develop a new generation of precast concrete bridge columns and connections with seismic performance that is equal to or better than columns built using conventional cast-in-place technology.



A cast-in-place footing ready for casting concrete is used as a benchmark.

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Improved Bridge Columns for Seismic Areas

WHAT DID WE DO?

Caltrans, in partnership with the University of Nevada, Reno, constructed eight different half-scale column models to test precast column connections. One column was a cast-in-place model to provide a benchmark for comparing the seismic performance of the other columns. The researchers developed and evaluated different types of connections, some using couplers to connect reinforcing bars and others using grouted ducts. To enhance the columns' seismic performance, the researchers incorporated advanced materials known to have superior strength.

One goal was to develop and proof-test connection and column designs that incorporated ultra high-performance concrete, a durable, super-concrete with high strength, a fiber-reinforced grout that can bend without falling apart, and bars made with nickel and titanium, which have the ability to bring the bridge back to its original position as it sways back and forth. The team assessed the advantages and disadvantages of each model to help engineers decide which type to use for a particular design.

Completed cast-in-place column model

WHAT WAS THE OUTCOME?

The research developed several types of proof-tested, practical precast bridge columns and connections, enabling engineers to choose optimal columns for a particular bridge to resist seismic forces. Connections using grouted ducts instead of couplers as a means to simplify construction were added to the list of reliable choices.

WHAT IS THE BENEFIT?

Incorporating innovative materials instead of conventional steel and concrete allow bridge engineers to design for higher standards. Most of the new generation of precast bridge columns have a seismic performance that is equal to or better than traditional cast-in-place columns. Using precast columns decreases construction time, traffic impact, and potentially cost. The precast columns are built with advanced materials that enhance bridge resiliency, substantially reduce post-earthquake damage and repair costs, and lessen the vulnerability of bridge columns to permanent side movements that render the bridge useless. Bridges can remain open to traffic, even after strong earthquakes. These unique features help ensure life-time serviceability of highway bridges in high seismic regions.

LEARN MORE

To view the complete report:
http://wolfweb.unr.edu/homepage/saiidi/caltrans/nextgen.html

Test setup

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Research Results

Length Requirements for Embedded Bridge Column Shafts

New data shows that bar lengths can be reduced, saving construction costs

Seismic

FEBRUARY 2015

Project Title:
Required Embedment Length of Column Reinforcement Extended into Type II Shafts

Task Number: 2240

Start Date: October 18, 2011

Completion Date: December 31, 2013

Product Category: New or improved technical standard, plan, or specification; new or improved decision support tool, simulation, model, or algorithm (software)

Task Manager:
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WHAT WAS THE NEED?

Cast-in-drilled-hole piles are frequently used to support reinforced concrete bridge columns because they have smaller footprints than spread footings or pile caps. Using enlarged pile shafts (Type II) also provides more tolerance in pile positioning and prevents the formation of below-surface plastic hinges in the piles in the event of a severe earthquake, making it easier to perform post-earthquake inspections. The Caltrans Seismic Design Criteria (SDC) specifications require that the diameter of the Type II shaft be at least 2 feet larger than the cross-section dimension of the column. Hence, the column reinforcement extended into the pile shaft forms a non-contact splice with the shaft reinforcement. Because information on the performance of these splices is lacking, the SDC specification for the embedment length is rather conservative, especially for large-diameter columns (No. 14 and 18), complicating construction and increasing costs. Experimental data was needed to assess whether the minimum embedment length could be reduced. In addition, the development length requirements for large-diameter bars in the American Association of State Highway and Transportation Officials (AASHTO) bridge design specifications are largely based on experimental data obtained from smaller bars. Because of a lack of data, tensile lap splices are not permitted for bars larger than No. 11.

WHAT WAS OUR GOAL?

The goal was to determine the minimum embedment length required for column longitudinal reinforcement extended into Type II shafts and the necessary transverse reinforcement required in the shaft's bar anchorage region.

Bond-slip test

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Length Requirements for Embedded Bridge Column Shafts

WHAT DID WE DO?

Caltrans, in partnership with the University of California, San Diego Department of Structural Engineering, examined the bond-slip behavior, bond strength, and anchorage capacity of large-diameter bars in Type II shafts. To identify the minimum embedment length for column reinforcement and validate new design formulas for the transverse reinforcement in the anchorage region of the shaft, the researchers tested four full-scale column-shaft assemblies of differing quantities and sizes of longitudinal reinforcing bars, embedment lengths, and quantities of transverse reinforcement in the columns and shafts under quasi-static cyclic lateral loading.

WHAT WAS THE OUTCOME?

The bond strength and cyclic bond deterioration of large-diameter bars is similar to smaller bars for well-confined situations comparable to a Type II shaft. The AASHTO length requirements for large-diameter bars are adequate to develop tensile strength. However, when considering possible uncertainties in material properties and construction quality, the conducted reliability analysis indicated that the AASHTO requirements have an acceptable reliability level to develop a bar's expected yield strength but do not have the desired reliability to develop its full tensile capacity. Based on these findings, the researchers propose design recommendations that significantly reduce the embedment length but increase the recommended quantity of transverse reinforcement for the shaft's bar anchorage region. Lowering the amount of transverse reinforcement to the new AASHTO formula could result in more severe splitting cracks, leading to premature bond failure. One test showed that an engineered steel casing was effective in controlling tensile splitting cracks in the shaft.

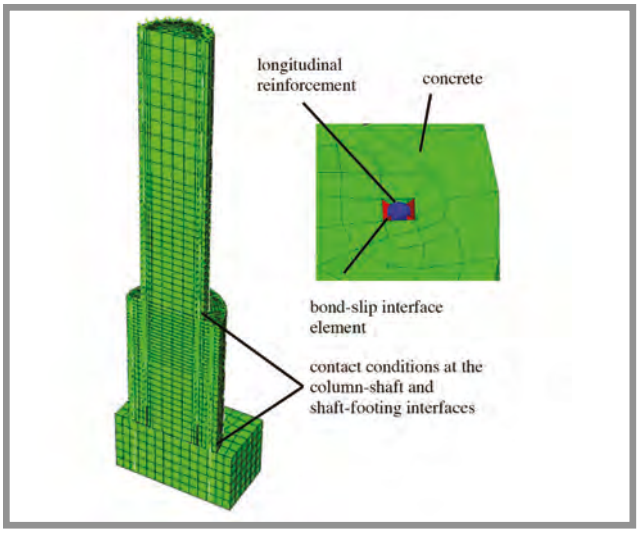
Column-shaft assembly instrumented

WHAT IS THE BENEFIT?

Although this study recommends that the amount of transverse reinforcement be higher than required by Caltrans and AASHTO specifications, it also demonstrates that the embedment length can be reduced by as much as 50%, significantly lowering the construction costs for large-diameter Type II shafts. Using engineered steel casings to confine the shaft can also reduce the amount of reinforcing hoops in a shaft and effectively control tensile splitting cracks, thus minimizing the need for post-earthquake damage repair for these shafts.

LEARN MORE

To view the complete report:
www.dot.ca.gov/newtech/researchreports/reports/2013/final_report_task_2240.pdf



Finite-element model of column-shaft assembly

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Research Results

Seismic

Repairing Earthquake-Damaged Columns with Fractured Bars

Rebar couplers and fiber-reinforced polymer jackets provide a quick way to repair damaged columns

FEBRUARY 2015

Project Title:
Repair of Earthquake-Damaged Columns with Fractured Bars

Task Number: 2179

Start Date: June 13, 2011

Completion Date: March 31, 2014

Product Category: Improved technical standard, plan, or specification

Task Manager:
Peter Lee
Research Contract Manager
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WHAT WAS THE NEED?

Reinforced concrete bridge columns undergo different levels of damage in an earthquake depending on the intensity of the ground shaking, type of earthquake, and the force or deformation demand on the individual members. Repairing earthquake-damaged reinforced concrete columns with fractured bars is especially challenging. Dependable and practical methods to repair columns with fractured reinforcement are needed to restore the functionality of the bridge as effectively and efficiently as possible.

WHAT WAS OUR GOAL?

The goal was to develop methods to restore earthquake-damaged reinforced concrete bridge columns with fractured longitudinal bars to their original performance.

Concrete demolition in progress

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Repairing Earthquake-Damaged Columns with Fractured Bars

Research Results

WHAT DID WE DO?

Caltrans and the University of Nevada, Reno Center for Advanced Technology in Bridges and Infrastructure collaborated with the Missouri University of Science and Technology and the University of Houston to develop methods to restore damaged columns. The project tested three concrete bridge column specimens to failure using slow cyclic loading to produce fractured and buckled longitudinal bars. The researchers then repaired two columns by removing segments of the longitudinal bars in the plastic hinge region and replacing them by connecting new bar segments with undamaged longitudinal bars using mechanical bar couplers. The team tested two different types of bar couplers, both approved by Caltrans as ultimate splices. To install the new bar segments, the existing spiral reinforcement was removed but not replaced. After the concrete was replaced, a carbon fiber-reinforced polymer (CFRP) jacket was installed around the column to provide the function of the removed spirals. The researchers repaired the third column without repairing the longitudinal bars. Instead, CFRP strips and a CFRP jacket constructed with prefabricated laminates were installed on the column's surface and extended into pockets dug into the footing around the column base. The repaired columns were then tested to evaluate the effectiveness of each type of repair. The procedures and experimental results were documented.

Column R-Calt-1 with couplers and new replacement longitudinal bar segments in place

WHAT WAS THE OUTCOME?

The two columns repaired with mechanical bar couplers in the plastic hinge region did not sustain damage during the test, indicating that this method restores the column's strength and deformation capacity. Both types of couplers were effective. The column that was repaired with externally bonded prefabricated CFRP strips and jacket was also able to restore the column strength and deformation capacity without requiring replacement of the internal reinforcement.

WHAT IS THE BENEFIT?

Bar couplers are currently not allowed in critical zones of bridge columns. This research shows that it is possible to successfully use mechanical bar couplers in the plastic hinge regions of columns and achieve a ductile response. In addition, the alternative prefabricated CFRP laminate system can be constructed quickly, saving valuable time in the repair process. This research expands the column repair options for Caltrans bridge engineers, especially for damaged columns with fractured bars.

LEARN MORE

For more information about this project:
http://wolfweb.unr.edu/homepage/saiidi/caltrans/fractured.html

R-Calt-1 after concrete repair

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Research Results

Seismic

JANUARY 2015

Project Title:
Probabilistic Damage Control Approach for Seismic Design of Bridges

Task Number: 2280

Start Date: June 1, 2011

Completion Date: May 31, 2014

Product Category: New technical standards and specifications

Task Manager:
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Using a Probabilistic Damage Control Approach to Design Bridges

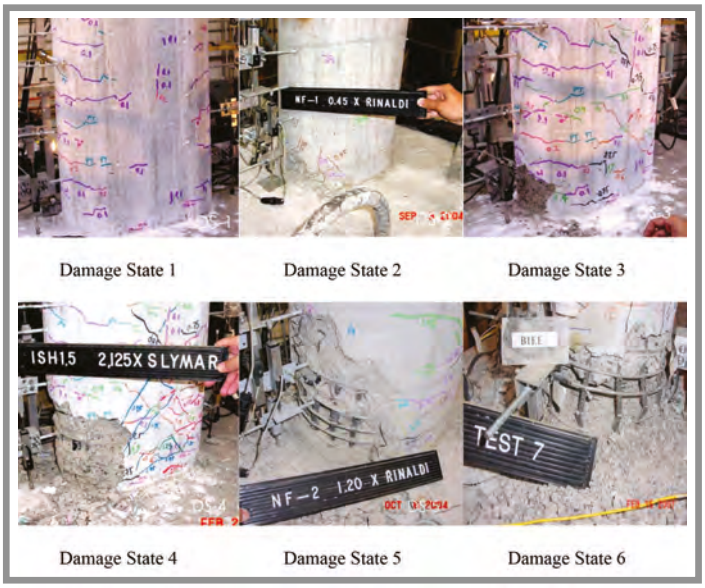
PDCA helps assess post-earthquake performance and offers broader design options

WHAT WAS THE NEED?

Earthquake engineering is transitioning away from using deterministic design criteria, which considers the largest magnitude earthquake at the nearest fault to the site to assess the potential level of damage. A relatively new design concept based on probabilistic seismic analysis incorporates the uncertainties in seismic demand and structural response to better control bridge performance. The Probabilistic Damage Control Approach (PDCA) evaluates how a structure is likely to perform under a given seismic hazard. PDCA incorporates the extent of column lateral plastic deformation at different probable earthquake levels and scenarios based on experimental results.

WHAT WAS OUR GOAL?

The goal was to develop a probabilistic damage control approach for the seismic design of bridge columns.



Possible apparent damage states of bridge columns

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Using a Probabilistic Damage Control Approach to Design Bridges

WHAT DID WE DO?

Caltrans, in partnership with the University of Nevada, Reno Department of Civil and Environmental Engineering, developed a probabilistic approach by incorporating the movement of the bridge as defined by the level of damage (damage index). The researchers subjected 22 bridge column models to seismic loads for over 140 use cases and correlated the bridge movement to visible damage states. They included a range of variables to capture nearly all possible bridge column designs, soil types, and earthquake intensities. Each column was analyzed under 25 near-field and far-field ground motions. The researchers also statistically analyzed the demand damage index to develop a load model and to determine the reliability index for each damage state.

WHAT WAS THE OUTCOME?

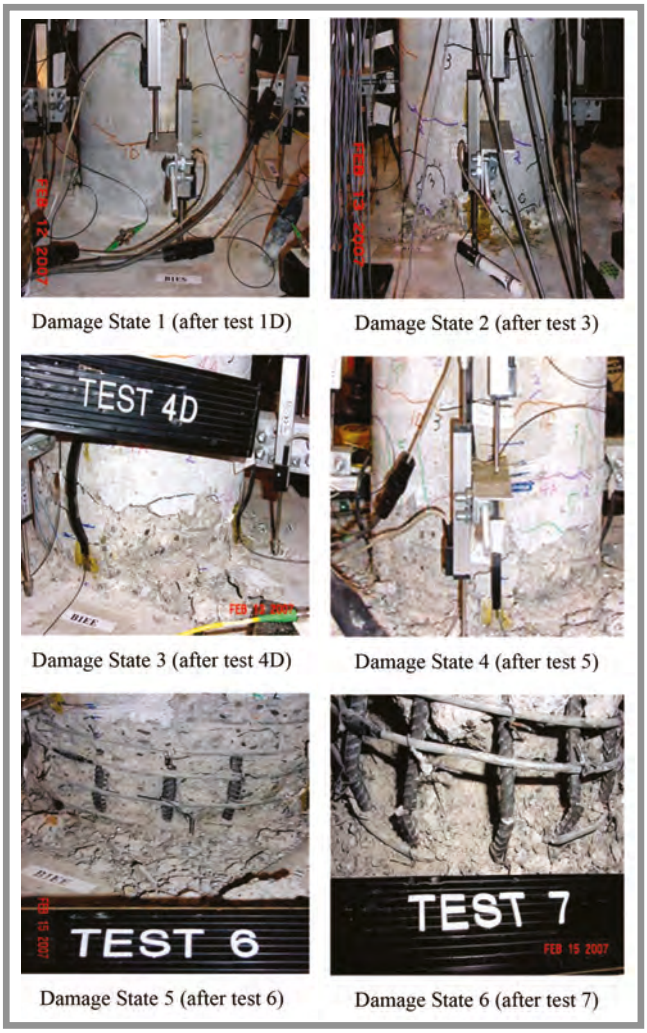
The results showed that the proposed method could be effectively used for designing new bridges as well as seismically assessing existing bridges. The researchers developed charts and equations for designing bridge columns and four illustrative examples to facilitate applying PDCA. Future research would expand the study to include old bridge columns that need to be evaluated. The new phase will help Caltrans engineers explore retrofit strategies using a probabilistic approach specific to the bridge rather than a deterministic "all or nothing" approach, which can be unnecessary and costly.

WHAT IS THE BENEFIT?

Under the current practice, standard bridges are designed mainly based on the seismicity of the site. Other factors, such as the average daily traffic, consequence of a temporary bridge closure, and post-earthquake repair costs, do not enter the design. The PDCA method allows for flexibility in design to account for economy, safety, and other concerns. PDCA also helps maintenance engineers make faster and better assessments of earthquake damages when timing is crucial in deciding whether to open a bridge or halt traffic.

LEARN MORE

To view the complete report:
http://wolfweb.unr.edu/homepage/saiidi/caltrans/Probablistic/PDFs/CCEER-14-02CompleteAug29-2014.pdf



Damage states for bent 1 east column plastic hinge

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Research Results

Column Base Pipe Pins for Accelerated Bridge Construction

New pipe pin connections speed up construction and reduce the size of bridge foundations

Seismic

JANUARY 2015

Project Title:
Experimental and Analytical Seismic Studies of Bridge Piers with Innovative Pipe Pin Column-Footing Connections and Precast Cap Beams

Task Number: 2281

Start Date: January 1, 2011

Completion Date: May 31, 2014

Product Category: New technical standards and specifications

Task Manager:
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Research Contract Manager
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WHAT WAS THE NEED?

Prefabricated bridge elements, such as columns and bent cap beams, expedite bridge construction. Connecting the prefabricated elements to the rest of the bridge is critical to resisting traffic and earthquake loads. However, the connections used for bridges in low seismic zones do not always have sufficient ductility and strength to withstand a seismic event. Cost-effective, practical, and reliable bridge connections must be designed for California's bridges.

Caltrans bridge engineers had developed pipe pins for connections at the top of columns for conventional, cast-in-place bridge construction. Previous studies showed that the pipe pins can be adapted for Accelerated Bridge Construction, but they cannot be used at the bottom of columns. The bottom of the column can experience uplift force under horizontal loading, which must be resisted without inducing flexural strength at the pin, because the connection would no longer be "moment-free."

WHAT WAS OUR GOAL?

The goal was to design, test, and analyze two types of column connections to reduce the moment transfer between structural elements: pipe pin connections for the base of precast or cast-in-place bridge columns to the footing, and pocket connections for the top of precast columns to the cap beam.

Pedestal with pipe pin connection at base

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Column Base Pipe Pins for Accelerated Bridge Construction

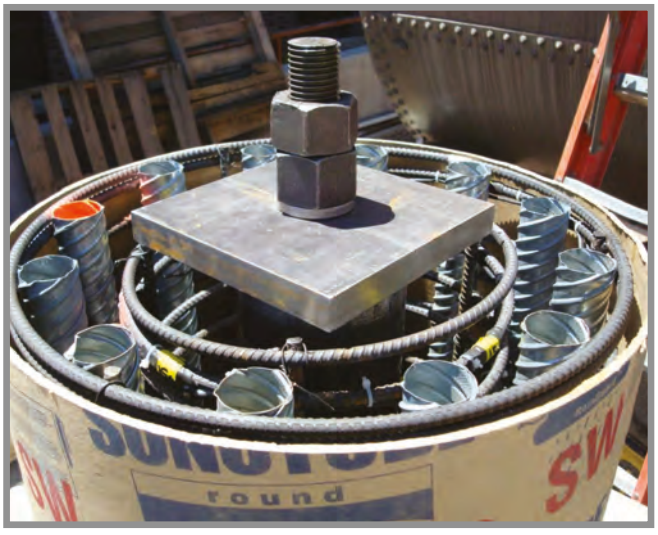
Research Results

WHAT DID WE DO?

Caltrans, in partnership with the University of Nevada, Reno Large Scale Structural Laboratory, tested a large-scale two-column bent model under simulated earthquake loading. The model was composed of a precast concrete pedestal, a precast engineered cementitious composite (ECC)-concrete column, a cast-in-place reinforced concrete column, a precast cap beam, and two single footings. The columns were connected to the footing and cap beam using pipe pin and pocket connections, respectively. The researchers subjected the pins to direct tension to investigate the failure mode and determine their ultimate tensile capacity.

The researchers also designed new pocket connections, which are constructed by leaving an opening in the cap beam and placing a prefabricated column in the pocket followed by grouting, because they can be an efficient way of connecting the bridge pieces. When properly designed and constructed, these connections provide strong seismic joints that can resist demanding earthquakes. To keep bridges operational even after strong earthquakes, the team investigated using concrete with special fibers to enhance seismic resistance.

The team calibrated analytical models using experimental data and then used them to simulate the effect of earthquakes on various pipe pin designs. Results of the parametric studies, along with the experimental observations, led to an accurate method to estimate seismic loads and designing pipe pins.



Pipe pin in pedestal

WHAT WAS THE OUTCOME?

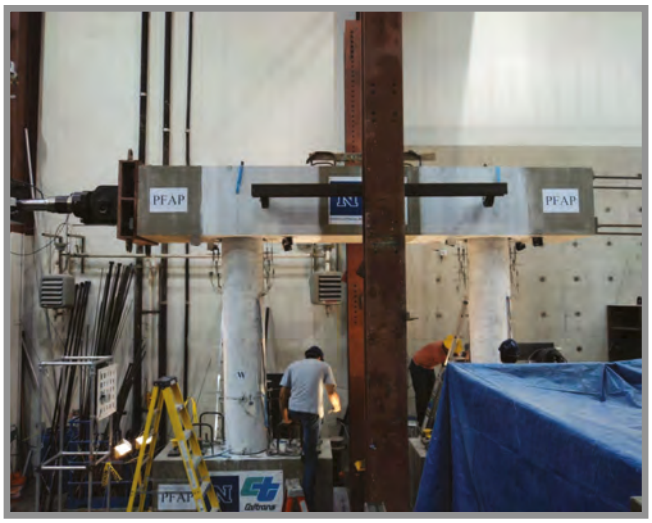
The research designed a proof-tested, reliable pipe pin design for column footing connections. Pocket connections were refined and made ready for real-world application in California bridges. Using concrete with special fibers demonstrated that earthquake damage can be minimized. The precast ECC-concrete column demonstrated that this material can reduce repair costs after strong earthquakes.

WHAT IS THE BENEFIT?

The precast cap beam incorporating the proposed pocket connections meets Caltrans design requirements for strong earthquakes. The connection can be used in both conventional and prefabricated bridge construction. The proposed base pipe pin connection decreases the size of the foundation compared to fixed base connections, which significantly reduces bridge costs.

LEARN MORE

To view the complete report:
http://wolfweb.unr.edu/homepage/saiidi/caltrans/basepins.html



Two-column pier with base pipe pins

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Caltrans Division of Research, Innovation and System Information

Research Results

Comparing Adaptive and Time-of-Day Traffic Control Systems

Adaptive signal coordination can reduce congestion using real-time traffic information

Transportation Safety and Mobility

FEBRUARY 2015

Project Title:
Field Test the Effectiveness of Adaptive Traffic Control for Arterial Signal Management

Task Number: 2272

Start Date: October 18, 2011

Completion Date: August 31, 2013

Product Category: Evaluation of new commercial products to determine if they meet Caltrans' needs; new or improved tool

Task Manager:
John Slonaker
Senior Transportation Electrical Engineer (specialist)
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WHAT WAS THE NEED?

Adaptive traffic control systems adjust traffic signals—cycle length, green times, offsets—based on real-time traffic conditions, easing traffic congestion and optimizing arterials. They can also respond to unexpected or unplanned events, such as incidents and adverse weather. To explore its use on state highways and arterials, previous tasks had simulated several adaptive signal control algorithms with the results showing improved traffic flow and reduced side-street delay over traditional time-of-day (TOD) controls that use preprogrammed, daily signal schedules. The next step was to compare the performance of an adaptive signal control system under real-world conditions to find an effective strategy for arterial highways and corridor management.

WHAT WAS OUR GOAL?

The goal was to compare the performance of an adaptive traffic control system to a fixed-cycle, time-of-day coordination scheme using simulations and field tests.

Bluetooth detector in portable case

Mounting a Bluetooth detector on the crosswalk flashing beacon standard

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WHAT DID WE DO?

The Los Angeles area uses the Adaptive Traffic Control System (ATCS) to operate a nine-intersection arterial on Highway 1. To compare the performance of this system during peak commute times and the less-congested midday period, Caltrans, in partnership with the University of California, Berkeley Partners for Advanced Transportation Technology program, designed six TOD signal coordination plans for each direction. The three TOD-230 plans had cycle lengths comparable to those of ATCS, constrained to 230 seconds during the morning and afternoon peak periods. The three TOD-Optimized plans used optimized cycle lengths as determined by Synchro traffic simulation software. Using Bluetooth detectors, the researchers collected about 5,000 individual travel times in each direction. They also monitored side-street queue lengths to determine if those splits had sufficient time.

WHAT WAS THE OUTCOME?

All three strategies performed similarly during midday when traffic volumes and congestion were relatively low. ATCS demonstrated the best overall performance, but the TOD-230 PM peak plan did best in the northbound direction, with an average travel time savings of 2.4 minutes over ATCS and 5.5 minutes over the TOD-Optimized plan. In the southbound direction, ATCS outperformed both fixed-time plans in the AM peak period, with an average arterial travel time savings of 3 minutes over the TOD-230 plan.

A. Northbound Direction

CONTROL STRATEGY	TIME PERIOD AM	MIDDAY	PM
ATCS	2	3	2
TOD-230	3*	1	1
TOD-OPTIMIZED	1	2	3*

B. Southbound Direction

CONTROL STRATEGY	TIME PERIOD AM	MIDDAY	PM
ATCS	1*	2	2
TOD-230	3	1	1
TOD-OPTIMIZED	2	3	3*

** Differences in Performance are Statistically Significant*

Ranking of control strategies based on travel time data, with 1 being best

ATCS had some inefficiencies during oversaturated traffic conditions due to operating each intersection independently as opposed to part of the entire arterial. For example, during the afternoon peak, the primary bottleneck was the intersection of Sunset Blvd., where ATCS gave up to 20% more green time than necessary to the side street, causing delays for the mainline travelers. Consequently, this condition often resulted in giving too much green time to the mainline at the intersection upstream of Sunset Blvd., which provided no benefit to the drivers heading toward the bottleneck.

WHAT IS THE BENEFIT?

Poor traffic signal timing contributes to traffic congestion and delay. Adaptive signal control technology adjusts the timing of lights to accommodate changing traffic patterns, smoothing traffic flow, shortening travel times, and reducing fuel usage and air pollutants caused by idling vehicles. Adaptive signal control can result in arterial travel time performance similar to or better than traditional TOD control, but with less time and effort spent by signal operations personnel making timing adjustments.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2014/final_report_task_2272.pdf

Study area: Nine intersections from California Incline to Topanga Canyon Blvd.

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Research Results

Reducing Onramp Bottlenecks with Coordinated Signals

Coordinating freeway ramp meters and arterial traffic signals improves traffic flow

Transportation Safety and Mobility

FEBRUARY 2015

Project Title:
Coordination of Freeway Ramp Meters and Arterial Traffic Signals Field Operational Test

Task Number: 2223

Start Date: April 7, 2010

Completion Date: December 31, 2013

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

Task Manager:
Hassan Aboukhadijeh
Project Engineer
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WHAT WAS THE NEED?

Arterial intersection traffic control maximizes flow by progressively coordinating traffic signals over a series of intersections. Conversely, freeway entrance ramp traffic control maximizes mainline flow by restricting traffic from entering the highway if the total demand (upstream mainline flow + expected entrance ramp flow) approaches or exceeds the capacity of the downstream mainline section. Another conflict is that arterial intersection traffic control groups vehicles into platoons, while freeway entrance ramp metering tends to break these groups into individual vehicles, usually one vehicle per green light. If an entrance ramp is at capacity, either through high arterial demand or low entrance ramp discharge, traffic can spill back into the arterial, exacerbating the situation. In current traffic operating practice, traffic control at freeway entrance ramps and arterial intersections are operated independently. This lack of coordination reduces performance on both roadways because they are interconnected. To improve overall system performance, balancing these two variables is critical.

WHAT WAS OUR GOAL?

The goal was to develop a strategy for coordinating freeway entrance ramp meters and arterial intersection traffic signals to optimize traffic flow and the performance of the overall system.

Taylor Street intersection at State Route 87 in San Jose was used to test coordinating arterial traffic signals with freeway ramp metering.

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Reducing Onramp Bottlenecks with Coordinated Signals

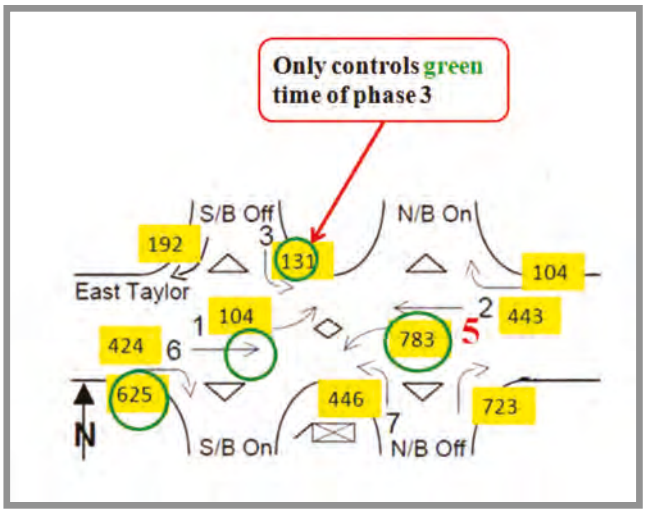
Research Results

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Berkeley Partners for Advanced Transportation Technology program, reviewed several sites that experience regular congestion at peak hours and have recurrent bottlenecks. The researchers selected the Taylor Street intersection at State Route 87 in San Jose and collected site traffic data to calibrate a microscopic traffic system model to simulate the field operational test results prior to deployment. After achieving positive results in the simulation, the ramp meter controller and the arterial signal controller were linked and coordinated. The research team then analyzed the before-and-after traffic data to evaluate the effectiveness of the coordination strategy.

WHAT WAS THE OUTCOME?

The data analysis indicated that the coordination strategy reduced the net delay at the Taylor Street intersection by 7%. The entrance ramp also had a higher flow, and the queue did not spill into the arterial. However, the freeway mainline traffic immediately upstream of the entrance ramp was unchanged. While the strategy improved traffic performance, it is also necessary to coordinate the freeway corridor, not just one entrance ramp, to improve mainline traffic.



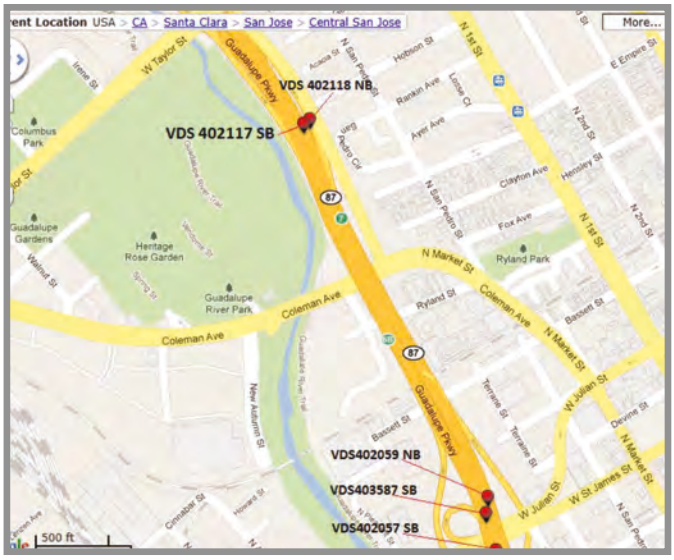
Phase assignment and vehicle count on April 3, 2012 at the Taylor intersection

WHAT IS THE BENEFIT?

It is possible to avoid bottlenecks by coordinating freeway ramp metering and arterial intersection traffic signals to regulate traffic flow onto the freeway. Optimizing traffic performance can be achieved with a practical, manageable coordination strategy, even with one intersection and one freeway entrance ramp. By maintaining traffic flow, idling is reduced and so are emissions. But to extend the improvements to the freeway mainline traffic, it is necessary to coordinate all the high-demand entrance ramps and relevant arterial intersections along a freeway corridor.

LEARN MORE

To view the complete report:
www.dot.ca.gov/newtech/researchreports/reports/2013/final_report_task_2223.pdf



Sensor locations near SR 87 and Taylor Street

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Research Results

Pedestrian Safety Improvement Program

Implementing a safety program to reduce pedestrian fatalities and injuries

Transportation Safety and Mobility

NOVEMBER 2014

Project Title:
Pedestrian Safety Improvement Program (PSIP)

Task Number: 2209

Start Date: August 9, 2011

Completion Date: March 31, 2014

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

Task Manager:
Jerry Kwong
Transportation Engineer, Electrical
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WHAT WAS THE NEED?

Over the past decade, pedestrians accounted for approximately 12% of all traffic fatalities in the United States, totaling more than 4,500 deaths per year. In California, the proportion of pedestrian fatalities is higher, at approximately 20% of traffic-related fatalities. Additionally, progress in reducing foot traffic fatalities in California has been slower than for vehicle fatalities. Passenger vehicle fatalities declined by 43% from 2006–12, but pedestrian fatalities by only 15%. Data also indicates that pedestrians are 37 times more vulnerable than the rest of roadway users in California—that is, they suffer 37 times more injuries than they inflict on others.

Improving pedestrian safety in California dovetails with efforts already underway. For example, Challenge Area 8 of the Strategic Highway Safety Plan has worked for several years to represent the needs of pedestrians at the state level and to develop achievable goals for improved pedestrian safety. Furthermore, the recent external evaluation by the State Smart Transportation Initiative highlighted the need for Caltrans to modify its efforts and programming to better reflect statewide goals of improved safety and mobility for non-motorized modes.

WHAT WAS OUR GOAL?

The goal was to identify opportunities and challenges to implement a pedestrian safety program to reduce fatalities and injuries.

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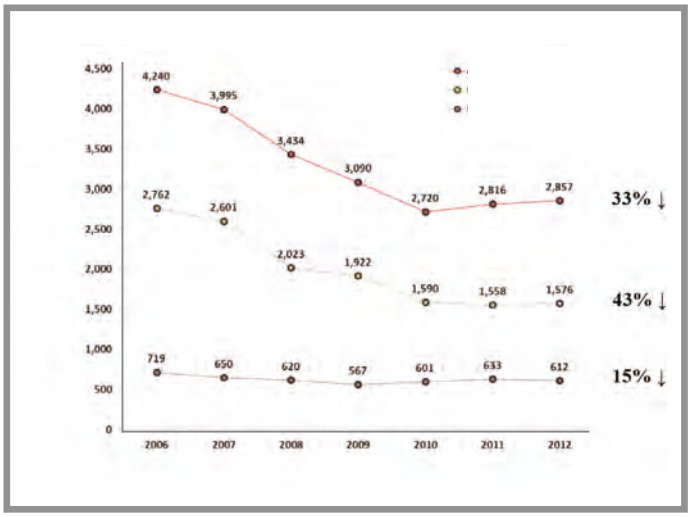
WHAT DID WE DO?

Caltrans, in partnership with the University of California, Berkeley Safe Transportation Research and Education Center, identified and conducted the following eight tasks for improving pedestrian safety. Each task's activities are intentionally pragmatic, with the purpose of helping Caltrans and the state make gradual ongoing progress toward enhancing pedestrian safety.

1. **Data access**—Tools to improve access to existing pedestrian safety data
2. **Pedestrian volume and infrastructure**—Model for urban arterials applicable across the state
3. **Data evaluation**—Pedestrian Safety Report Card, a snapshot of collisions and trip patterns statewide
4. **Hazard assessment**—New pedestrian hotspot monitoring method and reporting tool to identify hazardous locations at the district level
5. **Countermeasure selection**—Analysis of statewide incidence and severity of pedestrian collisions to guide the development of pedestrian crosswalk enhancements
6. **Economic appraisal**—Assessment of available resources to implement countermeasures and programs to improve pedestrian safety
7. **Funding sources and strategies**—Evaluation of various approaches to prioritizing countermeasures through cost-benefit analysis
8. **Institutionalization**—Survey of available and lacking training and education material about pedestrian safety



Pedestrian fatalities are declining at a slower rate than passenger vehicle fatalities.

WHAT WAS THE OUTCOME?

The researchers developed a preliminary set of tools and activities to monitor pedestrian safety across the state. They identified resources needed to address the imbalance between pedestrians and motorized roadway users. The project also provided recommendations for further development of the program to support institutionalization of pedestrian safety considerations statewide within Caltrans and as part of district-level safety analysis practices.

WHAT IS THE BENEFIT?

Pedestrians are the most vulnerable group of roadway users. California must improve transit conditions to improve pedestrian safety. This statewide analysis of pedestrian safety and the subsequent changes could lead to fewer injuries and fatalities on the California state highway system.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2014/final_report_task_2209.pdf

A collision profile page shows basic details and an interactive Google Street View.

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Research Results

Collecting Pedestrian Infrastructure and Volume Data

New database addresses the lack of injury and facility data for pedestrians

Transportation Safety and Mobility

NOVEMBER 2014

Project Title:
Developing a Plan to Collect Pedestrian Infrastructure and Volume Data for Future Incorporation into Caltrans Accident Surveillance and Analysis System Database

Task Number: 2302

Start Date: November 1, 2011

Completion Date: May 31, 2014

Product Category: New or improved decision support tool, simulation, model, or algorithm (software); new or improved manual, handbook, guidelines, or training

Task Manager:
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Project Engineer
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WHAT WAS THE NEED?

Caltrans and other state agencies maintain various data sources relevant to traffic safety, such as information on infrastructure, traffic volume, collisions, and violations. Planners, engineers, enforcement officials, educators, policy makers, advocates, and the general public rely on this data to develop countermeasures to reduce injuries and fatalities. However, data regarding "active transportation"—walking, biking, and transit—and related injuries and fatalities is not being collected.

The Caltrans Traffic Accident Surveillance and Analysis System – Transportation Systems Network (TASAS-TSN) database combines collision data with traffic volumes and roadway inventory of the entire state highway system, about 15,000 miles, but it is primarily vehicle-oriented and contains little information about infrastructure that serves pedestrians or bicyclists. It also does not include data about traffic volumes for these modes, despite the fact that facilities for pedestrians and bicyclists are available on many parts of the state transportation system. All transportation improvements need to be viewed as opportunities to enhance safety, access, and mobility for all travelers in California.

WHAT WAS OUR GOAL?

The goal was to evaluate the feasibility and cost of developing a supplementary database for pedestrian and bicycle infrastructure and volume data that could be incorporated into the TASAS-TSN database.

Photo courtesy of www.pedbikeimages.org/Elly Blue

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Collecting Pedestrian Infrastructure and Volume Data

WHAT DID WE DO?

Caltrans, in partnership with the University of California, Berkeley Safe Transportation Research and Education Center, developed a database architecture that can incorporate data collected in the field and through computer-generated remote imagery analysis. The protocols were tested in Districts 4 and 11. The pilot deployment involved using the remote computer imagery analysis technique on 100 miles of state highways and field-based data collection on 7 miles. The researchers tracked the time for both methods to estimate the costs for the entire state highway system. The team also worked with Fehr & Peers transportation consultants to analyze whether the commercial platform Miovision could accommodate data from automated collection sources for the volume database.

WHAT WAS THE OUTCOME?

Caltrans now has methods that it can use to collect key data about two important modes of transportation, walking and bicycling. To complete the data collection, it was estimated that would take about 4,000 hours using remote analysis of computer imagery and 9,000 hours using field observation. The researchers recommend primarily using remote image analysis and supplementing it with field checks when site visits are already scheduled for other purposes.

Roadway class	Mileage (mi)	Computer (hr)	Field (hr)
Urban freeways	3,533	157	59
Urban freeways < 4 lanes	28	1	1
Urban two lane roads	868	579	723
Urban multilane divided non-freeways	1,081	883	4,864
Urban multilane undivided non-freeways	176	86	792
Rural freeways	2,879	101	48
Rural freeways < 4 lanes	6	1	1
Rural two lane roads	12,422	1,402	1,470
Rural multilane divided non-freeways	1,125	656	718
Rural multilane undivided non-freeways	407	141	260
Total	22,525	4,006	8,935

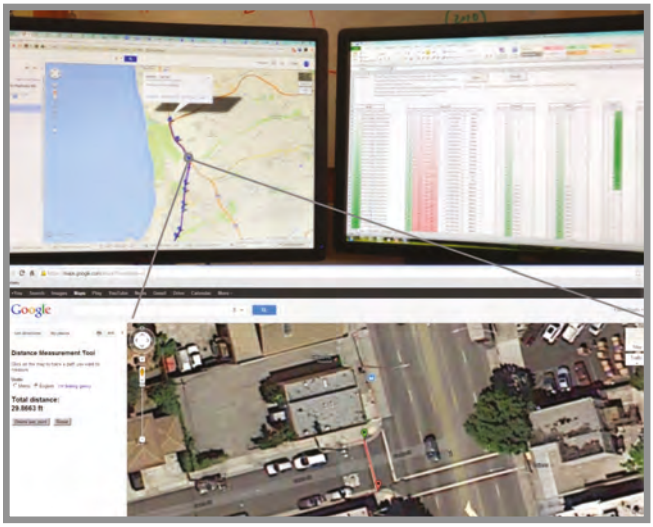
Estimated time required to collect pedestrian and bicyclist infrastructure data across the entire state highway system.

WHAT IS THE BENEFIT?

Biking and walking are integral elements of the transportation system that require distinct measures to improve safety and mobility. Systematic analysis of the needs and safety measures for pedestrian and bicycle facilities is necessary for Caltrans to improve the safety and effectiveness of the state transportation system for all travelers. The database and collection methods can also serve as a model for other agencies and jurisdictions, such as cities, counties, and metropolitan regions, to acquire similar data for local roads.

LEARN MORE

To view the complete report:
www.dot.ca.gov/newtech/researchreports/reports/2014/final_report_task_2302.pdf



The remote-analysis method uses computer imagery and a customized macro tool to collect infrastructure data.

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Research Results

Improving Freeway Weaving Conditions

New matrix helps calculate which designs are most effective for safety and performance

Transportation Safety and Mobility

NOVEMBER 2014

Project Title:
Weave Analysis Matrix and Microsimulation Methodology Refinement

Task Number: 1934

Start Date: June 15, 2012

Completion Date: June 13, 2014

Product Category: Improved manual, handbook, guidelines, or training; new decision support tool, simulation, model, or algorithm (software)

Task Manager:
Jose Perez
Transportation Engineer Electrical
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WHAT WAS THE NEED?

Weaving sections are common freeway design elements often near ramps and freeway-to-freeway connectors where vehicles must cross paths. When traffic exceeds capacity at a weaving area, congestion occurs, which can affect performance of the entire freeway section. A weaving area can also experience problems even when traffic is less than capacity due to the design and complexity of the vehicle interactions, resulting in poor traffic flow and potential safety issues.

Most of the existing weaving analysis methods are based on limited data that does not represent the entire range of geometric configurations, traffic volumes, and patterns in weaving areas. In 2010, a new weaving analysis method was included in the Highway Capacity Manual (HCM). Caltrans needed to evaluate the new methodology and upgrade its Weave Analysis Performance Matrix to better analyze conditions and recommend best use cases for weaving sections.

WHAT WAS OUR GOAL?

The goal was to upgrade and enhance the Weave Analysis Performance Matrix as a tool to more accurately analyze freeway weaving sections and improve the design and performance of new and existing facilities.

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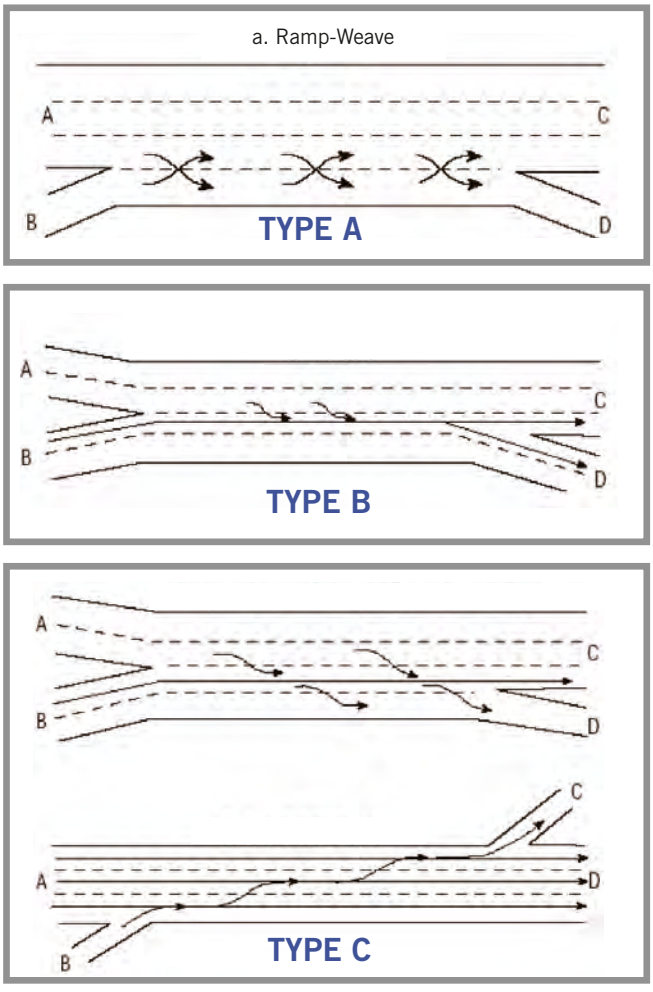
WHAT DID WE DO?

Caltrans, in partnership with the University of California, Berkeley Partners for Advanced Transportation Technology (PATH), conducted a comprehensive literature review on modern weaving analysis methods. The researchers then collected field data from a number of sites, with emphasis on the types of configurations lacking data in the performance matrix.

The team evaluated the accuracy of the HCM2010 capacity predictions and methodology by comparing the calculated flow rates to observed flow rates at weaving sites that are consistent bottlenecks. Researchers applied the proposed Performance Matrix on selected real-world weaving sections to assess the tool's accuracy. They performed additional analyses by applying the selected methods to synthetic datasets for design and operating conditions for which field data was not available.



Configurations of freeway weaving sections

WHAT WAS THE OUTCOME?

Although the HCM2010 method provides reliable estimates for balanced major weaving sections, it can overestimate the traffic densities and associated traffic flow for ramp and unbalanced weaving sections. On average, the difference between the observed and predicted densities was 8% for balanced weaving sections and 24% for ramp and unbalanced weaving sections.

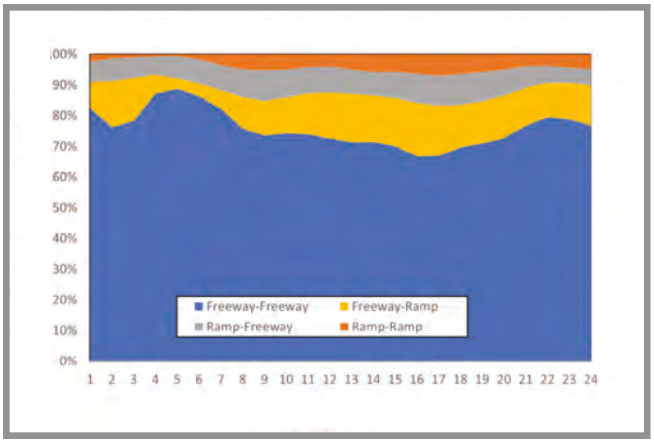
For the enhanced Weave Analysis Performance Matrix, researchers identified each method's strengths and limitations in predicting a weaving section's performance for a range of operating conditions, helping Caltrans staff to choose the best method for the weaving section under study. Each cell of the matrix represents a distinct design and operating condition, covering 144 typical weaving sections of two, three, four, and five lanes wide. Based on the comparison of the model prediction with field and synthetic data, each combination's performance is rated as good, partially good, inconsistent, or poor.

WHAT IS THE BENEFIT?

The new Weave Analysis Performance Matrix enables Caltrans to more accurately and consistently perform design analysis on freeway weaving sections, leading to better designed new facilities and improvements to existing interchanges. Improved weaving sections reduce bottlenecks, facilitate traffic flow, and create safer driving conditions.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2014/final_report_task_1934.pdf



Weaving movements captured from Bluetooth data

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Caltrans Division of Research, Innovation and System Information

Research Results

Upgrading California's Connected Vehicle Test Bed

Rejuvenated test bed provides a testing ground for the next generation of connected vehicle applications

Transportation Safety and Mobility

FEBRUARY 2015

Project Title:
California IntelliDrive Test Bed Upgrade (Federal Portion)

Task Number: 2297

Start Date: October 1, 2011

Completion Date: June 30, 2014

Product Category: New or improved tool or equipment

Task Manager:
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Transportation Engineer, Electrical
asfand.siddiqui@dot.ca.gov

WHAT WAS THE NEED?

California's Connected Vehicle Test Bed is a federally funded resource available to developers to test how connected vehicle technologies perform under real-world conditions. The test bed spans 11 consecutive intersections along a 2-mile stretch of the highly traveled arterial of El Camino Real SR-82 in Palo Alto. It provides an actual, operational environment where intersections, roadways, and vehicles are able to communicate through wireless connectivity. Established in 2005, the Connected Vehicle Test Bed was the nation's first Dedicated Short Range Communication (DSRC) test site to assess this wireless communication standard designed specifically for automotive use and connected vehicle applications and technologies.

After many years, the test bed needs to upgraded. It uses an earlier generation of DSRC radios that are now obsolete. However, the test bed's infrastructure and location play an important role in that it is in close proximity to many automobile research labs and the Silicon Valley. With new technology, the Connected Vehicle Test Bed can continue to serve as an incubator and proving ground for connected vehicle technology and applications.

WHAT WAS OUR GOAL?

The goal was to upgrade and rejuvenate the existing DSRC installations along Highway 82 so that the test bed is equipped and able to be a resource to develop and evaluate today's connected vehicle technologies.

DSRC radio at Page Mill Road on SR-82

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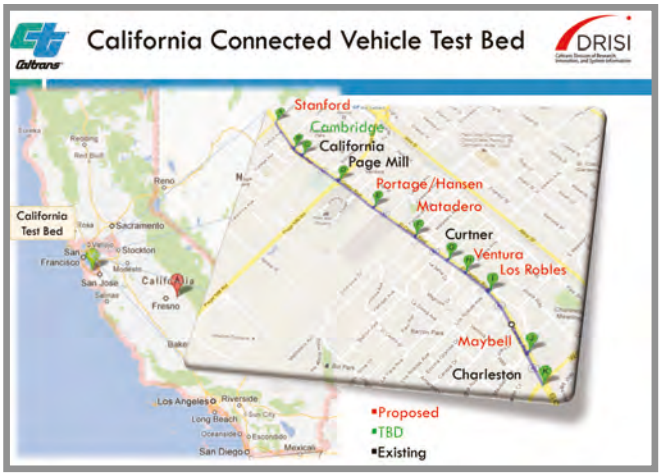
WHAT DID WE DO?

Caltrans, in partnership with the University of California, Berkeley Partners for Advanced Transportation Technology program, worked in close coordination with the U.S. Department of Transportation's Intelligent Transportation Systems Joint Program Office (ITS-JPO), which provided the contractors and upgraded DSRC radios to be installed. The researchers first surveyed the DSRC sites and developed installation designs. The contractors installed the DSRC radio systems and tested the connections between the radios and the local traffic signal controllers, along with a fourth generation, commercially available backhaul network. The backhaul connection provides links to the radios so that researchers performing experiments can monitor their tests. It also enables connections with other national connected vehicle test sites being developed by the ITS-JPO.

WHAT WAS THE OUTCOME?

The test bed is fully functional, consisting of 11 locations on Highway 82, and the radios can communicate with suitably equipped vehicles in their vicinity. It is now compliant with national standards and can be used as a platform to test the operational status of current applications.



WHAT IS THE BENEFIT?

The upgraded test bed provides up-to-date equipment and infrastructure for government agencies and the private sector to test their connected vehicle applications and perform certification activities. The test bed supports cutting-edge research for connected vehicle safety, mobility, and infrastructure-related applications, services, and components. It serves as a real-world platform for regional industries and research labs.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2015/final_report_task_2297.pdf

Locations of the 11 intersections on SR-82

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Caltrans Division of Research, Innovation and System Information

Research Results

Evaluating Highway Signage Legibility

New typeface does not improve readability and increases costs

Transportation Safety and Mobility

JANUARY 2015

Project Title:
Evaluation of Sign Guide Fonts, TPF-5(262)

Task Number: 2289

Start Date: July 19, 2011

Completion Date: April 15, 2014

Product Category: Improved technical standard, plan, or specification

Task Manager:
Matt Hanson
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WHAT WAS THE NEED?

Road signage is designed and positioned to help travelers safely navigate from one location to another. The Federal Highway Administration (FHWA) mandates signage standards to promote safety and consistency. The FHWA Series fonts, introduced over 50 years ago to maximize legibility at a distance and at high speed, are still being used, but over time the retroreflective material used for signage to enhance night visibility has been improved. The predominant font for large highway signs is Series E Modified. In the 1990s, the FHWA recommended enlarging the letters to increase visibility, which also meant increasing the size of the signs. As a result, the Clearview font was developed, and in 2004, the FHWA gave interim approval to optionally use the font. Because of the cost implications of changing signage, many states wanted more research before granting full approval. California alone has tens of thousands of guide signs on state and local highways, which would be costly to replace. One concern is that the E Modified font was evaluated in the 1980s using less-advanced retroreflective materials, while Clearview was tested with reflective materials that are much brighter and provide better visibility. To address these issues, the FHWA created a pooled fund study consisting of six states.

WHAT WAS OUR GOAL?

The goal was to compare the signage fonts in terms of visibility and safety and determine whether it is cost-effective to switch to the Clearview typeface.

Clearview (left); Series E Enhanced E Modified (middle); Series E Modified (right)

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WHAT DID WE DO?

Caltrans participated in this pooled fund study conducted at Texas A&M Transportation Institute to compare the Clearview, E Modified, and Enhanced E Modified fonts. Participants from two age groups, 18–35 years old and 65 years and older, drove a closed-course test track in an instrumented Dodge Caravan with low-beam headlights and rated the legibility of three full-sized overhead guide signs and one full-sized shoulder-mounted guide sign during daytime and nighttime conditions. None of the signs were equipped with sign lighting, and there was no roadway lighting.

WHAT WAS THE OUTCOME?

The Clearview font did not provide a statistically significant improvement in legibility. The Clearview font is slightly more expensive to implement than E Modified, so it is neither an improvement to safety nor a reduction in cost. Enhanced E Modified did not provide statistically significant improvement in legibility, but it does not add any cost if used as a replacement. In April 2014, the FHWA indicated that it might rescind interim approval for the Clearview font.

WHAT IS THE BENEFIT?

One of the goals of transportation professionals is to implement practices and facilities that promote uniformity to meet driver expectancy and minimize the costs of facility design and construction. Changes in these standards occur to improve safety or decrease costs without sacrificing safety. Based on this research, there is no reason for Caltrans to change fonts for safety or cost. Not switching to a new standard for guide signs allows funds to be dedicated toward investigating more durable retroreflective materials than the current sheeting, which has about half the lifespan of signs made with reflective buttons on a porcelain background.

LEARN MORE

To view the complete report:
www.dot.ca.gov/research/researchreports/reports/2014/final_report_task_2289.pdf

Testing overhead guide signs in the daytime and nighttime using specific letters for spacing and legibility

Appendix 1: Active NCHRP Projects with Caltrans Panel Membership

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.

Caltrans staff were on the following project panels as of July 2014, for which final reports have not been issued. Due to changes in staff, some of the listed panel members no longer work for Caltrans.

Project Number	Title	Panel Member	Division	Role	Start Date	End Date
D0148	Incorporating Pavement Preservation into Mechanistic Empirical Design Guide	Imad Basheer	Maintenance — Pavement	Member	2010	2013
D0151	Characterizing Slab/Base Friction for Improved Concrete Pavement Design	Dulce Rufino Feldman	Maintenance — Pavement	Member	2012	2015
D0152	Calibrated, Mechanistic-Based Models for Top-down Cracking of Hot Mix Asphalt Layers	Wilfung Martono	District 4 Water Quality	Member	2013	2016
D0224	Incorporating Economic Productivity Gains into Benefit-Cost Analysis for Transportation Investment Projects	Barry Padilla	Planning	Member	2012	2013
D03101	Support for the AASHTO IntelliDrive Strategic Plan	Greg Larson	Research, Innovation and System Information	Member	2011	2014
D03102	Auxiliary Turn Lane Design Guidance and Policy Upgrades	Larry Moore	Design	Member	2011	2013
D03105	Developing Design Criteria for Cost-Effective Multi-Lane Loop Ramp Design	Zhongren Wang	Traffic Operations	Member	2012	2015
D03109	Update Section 2B.07 of Manual on Uniform Traffic Control Devices—Multi-Way Stop Control	Roberta McLaughlin	Traffic Operations	Member	2013	2014
D0362	Guidelines for Accessible Pedestrian Signals	Craig Copelan	Traffic Operations	Member	2001	2013
D0399	Development and Application of Access Management Guidelines	Marc Birnbaum	Traffic Operations	Member	2009	2013
D0437	Long-Term Performance of Epoxy Adhesive Anchors	Madhwesh Raghavendrachar	Engineering Services	Member	2009	2013
D0720	Technical Guidance for Traffic Incident Management Performance Measurement Implementation	Larry Wooster	Traffic Operations	Member	2013	2014
D0721	Guidance for the Management of Traffic and Safety Assets	Augustin Rosales	Maintenance	Member	2013	2014
D0866	Trip-Generation Rates for Infill Land Use Developments in Metropolitan Areas of the U.S.	Terry L. Parker	Planning	Chair	2008	2013
D0878	Estimating Bicycling and Walking for Planning and Project Development	Chris Schmidt	District 11 Planning — Public Transportation	AASHTO Monitor	2010	2013
D0881	Collecting Accurate Motorcycle Travel Data to Reduce Rising Fatalities on the Nation's Highways	Mitchell Prevost	Traffic Operations	Member	2011	2013

Project Number	Title	Panel Member	Division	Role	Start Date	End Date
D0888	Project Planning and Scoping to Improve the Execution of Highway Projects	Marlon Flournoy	Planning	Member	2012	2014
D0890	Development of a Transportation Asset Management Cap Analysis Tool to Complement the AASHTO Transportation Asset Management Implementation Guide	Coco Briseno	Research, Innovation and System Information	Member	2013	2014
D0893	Guidebook on Agency Risk Management Strategies, Methods, and Tools	Michelle Tucker	Administration — Risk Management	Member	2013	Pending
D0899	Truck Freight Benefit Methodology Development—Phase 2	Barry Padilla	Planning	Member	2013	Pending
D0948	Field vs. Laboratory Volumetric and Mechanical Properties	Kee Y. Foo	Maintenance	Member	2009	2014
D0950	Performance-Based Specification for Binders Used in Chip Seals	Kee Y. Foo	Maintenance	Chair	2011	2014
D0952	Short-Term Laboratory Conditioning of Warm Mix Asphalt	Cathrina Barros	Engineering Services	Member	2012	2014
D0953	Asphalt Foaming Characteristics for Warm Mix Asphalt Applications	Joe Peterson	District 3 Construction	Member	2012	2014
D1077	Developing Guidelines for Global Positioning System Controlled Construction Machine Guidance and Required CADD Software	Jesus Mora	Design	Member	2009	2013
D1082	Performance-Related Specifications for Pavement Preservation Treatments	Nick Burmas	Research, Innovation and System Information	Member	2010	2013
D1083	Alternative Quality Systems for Application in Highway Construction	Jon Tappping	Construction	Member	2010	2013
D1084	Modulus-Based Construction Specification for Compaction of Earthwork and Unbound Base Materials	Terrie Bressette	Engineering Services	Member	2010	2014
D1085	A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects	Ray Tritt	Design	Member	2011	2013
D1086	Alternate Bidding of Pipe Materials	Charles C. Fielder Brian Syftestad	District 1 Construction	Member Member	2011 2011	2014 2014
D1088	Determining the Influence of Road Surfaces on Vehicle Noise at Locations Adjacent to a Roadway: Precision and Bias Statements	Bruce Rymer	Environmental Analysis	Member	2012	2015
D1090	Guidance for Complying with Environmental Protection Agency Effluent Limitation Guidelines for Construction Runoff	Scott McGowen	Environmental Analysis	Member	Pending	Pending
D1092	Risk Assessment of Materials Inspection, Testing and Acceptance Practices	Daniel Speer	Engineering Services	Member	2013	2015
D12101	Recommended AASHTO Load and Resistance Factor Design Specifications and Method of Structural Analysis for Bridge Structures with Energy Dissipation Mechanism in Their Columns	Ron Bromenschenkel	Engineering Services	Member	Pending	Pending
D1283	Calibration of Load and Resistance Factor Design—Concrete Bridge Design Specifications for Serviceability	Susan Hida	Engineering Services	Chair	2009	2013

Project Number	Title	Panel Member	Division	Role	Start Date	End Date
D1285	Roadway Bridges Fire Hazard Assessment	Kenneth R. Brown	Maintenance	Member	2010	2013
D1286	Bridge System Safety and Redundancy	Susan Hida	Engineering Services	Member	2010	2013
D1287	Development of System Fracture Analysis Methods for Fracture Critical Steel Bridges	Lian Duan	Transportation System Information	Member	2011	2014
D1293	Structural Testing and Design Methodology for Single-Column, Single-Shaft Foundation Considering the Flexural Capacity of Steel Casing	Amir Malek	Engineering Services	Member	2013	2016
D1294	Minimum Flexural Reinforcement Laboratory Testing	Don L. Nguyen-Tan	Engineering Services	Member	2013	2016
D1297	Guide Specification for the Design of Concrete Bridge Beams Prestressed with CFRP Systems	Jim Gutierrez	Engineering Services	Member	2013	2016
D1298	Guidelines for Tolerances for Prefabricated Bridge Elements and Systems	Dorie Mellon	Engineering Services	Member	2014	Pending
D1304	Guidelines for the Development of Highway Ops Equipment Replacement Life Cycle	Lisa Kunzman	Equipment	Member	2014	Pending
D1422	NCHRP Effective Removal of Pavement Markings	Linus K. Motumah	Maintenance	Member	2010	2013
D1423	Quantify the Information Necessary to Guide Bridge Preservation Decisions	Paul Cooley	Maintenance	Member	2011	2015
D1426	Culvert and Storm Drain Inspection Manual	Parviz Lashai	Maintenance	Member	2012	2014
D1428	Condition Assessment of Bridge Post-Tensioning and Stay Cable Systems Using Nondestructive Evaluation Methods	Robert A. Reis	Engineering Services	Member	2012	2015
D1429	Developing a Consistent Coding and Training System for Emergency Structure Inspections	Herby Gerald Lissade	Maintenance	Member	Pending	Pending
D1432	Proposed Revisions to the AASHTO Movable Bridge Inspection, Evaluation, and Maintenance Manual	Alan Torres	Engineering Services	Member	Pending	Pending
D1433	Guidelines for Including Pavement Preservation in Life-Cycle Cost Analysis	William K. Farnbach	Maintenance – Pavement	Member	2014	Pending
D1539	Superelevation Criteria for Horizontal Curves on Steep Grades	Antonette C. Clark	Design	Member	2010	2013
D1543	Update of the TRP Access Management Manual	Marc Birnbaum	Traffic Operations	Member	2011	2013
D1544	Mobile Light Detection and Ranging Standards for Transportation Agencies	Thomas Taylor	Information — Technology Security	Chair	2011	2015
D1547	An Assessment of Geometric Design Policies and Processes	Dale Widner	District 2 Design	Member	2013	2015
D1549	Geometric Design Guidelines for Managed Lanes	Joseph Rouse	Traffic Operations	Member	Pending	Pending
D1550	Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation Projects	Dale Widner	District 2 Design	Member	2013	2015

Project Number	Title	Panel Member	Division	Role	Start Date	End Date
D1605	Development of Cost-Effective Treatments for Roadside Ditches to Reduce the Number and Severity of Roadside Crashes	Karen M. Jewel	District 11 Traffic Operations	Member	2010	2014
D1748	Development of a Strategic National Highway Infrastructure Safety Research Agenda	Jeanne E. Scherer	Legal	Member	2010	2013
D1749	Noteworthy Practices in Crash Reporting and Safety Programs on Indian Tribal Reservations	Charles C. Fielder	District 1	Chair	2011	2014
D1754	Consideration of Roadside Features in the Highway Safety Manual	Craig Copelan	Traffic Operations	Member	2011	2014
D1756	Development of Crash Reduction Factors for Uncontrolled Pedestrian Crossing Treatments	Brian Alconcel	Traffic Operations	Member	2012	2014
D1761	Effect of Work Zone Crash Risks and Guidance on Countermeasures	Theresa Drum	Maintenance	Chair	2012	2015
D1769	Development of Strategic Plan for Transforming Traffic Safety Culture	Joe Horton	Research, Innovation and System Information	Member	Pending	Pending
D1816	Self-Consolidating Concrete for Cast-in-Place Concrete Bridges and Tunnels	Madhwesh Raghavendrachar	Engineering Services	Member	2011	2014
D2005	Synthesis of Information Related to Highway Problems	Richard D. Land	Design	Member	1967	Ongoing
D2006	Legal Problems Arising Out of Highway Programs	Joann Georgallis	Legal	Member	1968	Ongoing
D2007	Research for AASHTO Standing Committee on Highways	Richard D. Land	Design	Member	1968	Ongoing
D2030	Innovations Deserving Exploratory Analysis	Michael D. Miles	District 7	Member	1992	2014
D2059	Surface Transportation Security Research	Herby Gerald Lissade	Maintenance	Member	2002	Ongoing
D205936	Catastrophic Transportation Emergency Management Guidebook	Herby Gerald Lissade	Maintenance	Chair	2002	Ongoing
D205939	Synthesis of Airport Closings and Emergency Evacuation Problems	Herby Gerald Lissade	Maintenance	Member	2002	Ongoing
D205948	Effective Practices for the Protection of Transportation Infrastructure from Cyber Incidents	Rene T. Garcia	Homeland Security	Member	2002	2014
D206300B	Performance Measurement Tool Box and Reporting System for Research Programs and Projects	Lawrence H. Orcutt	Research, Innovation and System Information	Member	2010	2014
D2065	Research for the AASHTO Standing Committee on Public Transportation	Jila Priebe	Planning	Member	2004	Ongoing
D206800A	United States Domestic Scan Program	Nancy L. Chinlund	Research, Innovation and System Information	Member	2004	2013
D2068A	Best Practices for Addressing Access and Parking Needs of Non-Resident Users of Rail and Intermodal Transportation Station in Transit-Oriented Developments	Jila Priebe	Mass Transportation	Member	2004	Ongoing

Project Number	Title	Panel Member	Division	Role	Start Date	End Date
D208302	Expediting Future Technologies for Enhancing Transportation System Performance	Marco Ruano	District 7 Traffic Operations	Member	2009	2013
D208306	Effects of Socio-Demographics on Travel Demand	Judy Lang	Traffic Operations	Member	2010	2013
D2084	Streamline and Simplify Right-of-Way Procedures and Business Practices	Mark L. Weaver	District 4 Right of Way and Land Surveys	Member	2010	2013
D2089	Intellectual Property Stewardship Guide for Transportation Departments	Lawrence H. Orcutt	Research, Innovation and System Information	Member	2011	2013
D2090	Improving Access to Transportation Information	Coco Briseno	Transportation System Information	Member	2011	2013
D2093	Development of Transportation Technology Transfer Primer on Best Practices	Mohamed Alkhadri	Research, Innovation and System Information	AASHTO Monitor	2012	2013
D2097	Improving Findability and Relevance in Transportation Information	Chad T. Baker	Transportation System Information	Member	2014	Pending
D2098	A Knowledge Management Primer for Transportation Agencies	Cris Rojas	Administration	Member	2014	Pending
D2228	Criteria for Restoration of Longitudinal Barriers: Phase II	Armando Garcia	District 11	Member	2012	2014
D2229	Performance of Longitudinal Barriers on Curves and Super-Elevated Roadway Sections	John R. Jewell	Research, Innovation and System Information	Member	2011	2014
D2434	Risk-Based Approach for Bridge Scour Prediction	Steve Ng	Engineering Services	Chair	2010	2013
D2435	Guidelines for Certification and Management of Flexible Rockfall Protection Systems	John Duffy	District 5	Member	2012	2013
D2436	Scour at the Base of Retaining Walls and Other Longitudinal Structures	Charles Ineichen	Maintenance	Member	2012	2015
D2437	Combining Individual Scour Components to Determine Total Scour	Kevin Flora	Maintenance	Member	2012	2015
D2438	Load and Resistance Factor Design Calibration of Differential Bridge Support Settlement	Amir Malek	Engineering Services	Member	2012	2015
D2534	Improving FHWA's Traffic Noise Model by Expanding Its Acoustical Capabilities and Applications	Bruce Rymer	Environmental Analysis	Member	2011	2013
D2535	Managing Rights-of-Way for Biomass Generation and/or Carbon Sequestration	Keith Robinson	Design	Chair	2011	2013
D2539	Developing Environmental Performance Measures and a Methodology for Incorporation into Performance Management Programs	Cindy Adams	Environmental Analysis	Member	2012	2014
D2541	Guidance for Achieving Volume Reduction of Highway Runoff in Urban Areas	Scott McGowen	Environmental Analysis	Chair	2012	2013
D2542	Bridge Runoff Treatment Analysis and Treatment Options	Keith Jones	Environmental Analysis	Member	2012	2013
D2545	Mapping Truck Noise Source Heights for Highway Noise and Barrier Analysis	Bruce Rymer	Environmental Analysis	AASHTO Monitor	2013	Ongoing

Appendix 2: Active ACRP Projects with Caltrans Panel Membership

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. ACRP is managed by the Transportation Research Board of the National Academies and sponsored by the Federal Aviation Administration.

Caltrans staff were on the following project panels as of July 2014, for which final reports have not been issued. Due to changes in staff, some of the listed panel members no longer work for Caltrans.

Project Number	Title	Panel Member	Division	Role	Start Date	End Date
DA0247	Assessing Aircraft Noise Conditions Affecting Student Learning: Case Studies	Philip Crimmins	Aeronautics	Member	Pending	Pending
DA0409	Assessing the Risks Associated with Maintaining Existing Airfield Separations at Older Urban Airports	Gary C. Cathey	Aeronautics	Member	2009	2013
DA1103	Synthesis of Information Related to Airport Problems	Gary C. Cathey	Aeronautics	Member	2005	Ongoing

Appendix 3: Active NCFRP Panels with Caltrans Panel Membership

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.

Caltrans staff were on the following project panels as of July 2014, for which final reports have not been issued. Due to changes in staff, some of the listed panel members no longer work for Caltrans.

Project Number	Title	Panel Member	Division	Role	Start Date	End Date
DF020	Resources and Procedures for Developing Local and Specific Freight Corridors Commodity Flow Databases	Diane Jacobs	District 7 Transportation System Information	Member	2009	2013
DF02501	Estimating Freight Generation Using Commodity Flow Survey Microdata	Douglas MacIvor	Transportation System Information	Chair	2012	2014
DF034	Alternative Technologies for Container Freight	Diane Jacobs	District 7 Transportation	Chair	2011	2013
DF038	Metropolitan Frameworks for Freight Project Delivery	Chad T. Baker	Transportation System Information	Chair	2012	2014
DF039	Creating Publicly Available Measures of Freight Trucking Activity	Diane Jacobs	District 7 Transportation System Information	Chair	2012	2013
DF041	Capacity and Level of Service Analysis for Trucks	Doug MacIvor	Transportation System Information	Member	2012	2014
DF044	Factors Influencing Freight Modal Shift	Doug MacIvor	Transportation System Information	Member	2013	2015

Appendix 4: National Committees with Caltrans Membership

Caltrans participates in a wide variety of national committees, subcommittees, and task forces that provide direction to the transportation system.

Caltrans staff were on the following national committees as of July 2014. Due to changes in staff, some of the listed committee members no longer work for Caltrans.

Committee Title	Committee Member	Division	Committee Role
AASHTO Board of Directors	Malcolm Dougherty	Executive	Member
Access Management	Marc Birnbaum	Traffic Operations	Member
Bridge Management	Michael B. Johnson	Engineering Services	Member
Committee for Review of U.S. DOT Truck Size and Weight Study	Susan Hida	Engineering Services	Member
Committee for the 10th National Conference on Transportation Asset Management	Garth Hopkins	Planning	Member
Committee on Implementing Research from SHRP 2	Malcolm Dougherty	Executive	Member
Council on Fiscal Management and Accounting	Clark Paulsen	Budgets	Member
Critical Transportation Infrastructure Protection	Herby Gerald Lissade	Maintenance	Member
Emerging and Innovative Public Transport and Technologies	Jane Perez	Mass Transportation	Member
Eminent Domain and Land Use	Joanne Georgallis	Legal	Member
Engineering Geology	John Duffy	Geology	Member
Environmental Issues in Transportation Law	David McCray	Legal	Member
Expert Task Group for Bridge Durability and Preservation	Barton J. Newton	Engineering Services	Member
Expert Task Group for Bridge Evaluation and Monitoring	Charles Sikorsky	Engineering Services	Member
Freeway Operations	Diana Gomez	Traffic Operations	Member
Freight Transportation Data	Doug MacIvor	Planning	Member
Freight Transportation Planning and Logistics	Diane Jacobs	System Information	Member
Geometric Design	Jerry Champa	Traffic Operations	Member
Highway Capacity and Quality of Service	Kevin Hanley	Design	Member
Highway Safety Performance	Craig Copelan	Traffic Operations	Member
Historic and Archeological Preservation in Transportation	Anmarie Medin	Environmental Analysis	Member
Intelligent Transportation Systems	Greg Larson	Research, Innovation and System Information	Member
Landscape and Environmental Design	Keith Robinson	Design	Member
Long-Term Bridge Performance Committee	Richard D. Land	Executive	Member
Maintenance and Operations Personnel	Lawrence H. Orcutt	Equipment	Member
Maintenance and Preservation	Michael B. Johnson	Engineering Services	Member
Maintenance and Preservation	Lisa Kunzman	Equipment	Member
Maintenance Equipment	Lisa Kunzman	Equipment	Chair
Managed Lanes	Joseph Rouse	Traffic Operations	Member
Modeling for the Design, Construction, and Management of Geosystems	Anoosh Shamsabadi	Engineering Services	Member

Committee Title	Committee Member	Division	Committee Role
National Transportation Product Evaluation Program	Lawrence H. Orcutt	Equipment	Member
NCHRP Review Panel 3	Joe Horton	Research, Innovation and System Information	Member
Oversight Committee for SHRP 2	Malcolm Dougherty	Executive	Member
Passenger Rail Equipment and System Integration	Stanton Hunter	Rail	Member
Pavement Management Systems	Peter Vacura	Maintenance	Member
Pavement Rehabilitation	Robert Hogan	Maintenance	Member
Portland Cement Concrete Pavement Construction	Dulce Rufino Feldman	Maintenance	Member
Research Advisory Committee	Coco Briseno	Research, Innovation and System Information	Member
Rigid Pavement Design	Dulce Rufino Feldman	Maintenance	Chair
Roadside Maintenance Operations	Jack Broadbent	Design	Member
Section Pavement Management	Dulce Rufino Feldman	Maintenance	Member
Seismic Design and Performance of Brides	Mike Keever	Engineering Services	Chair
SHRP 2 Technical Coordinating Committee for Capacity Research	Kome Ajise	Executive	Member
Special Committee on Transportation Security and Emergency Management	Steve Takigawa	Executive	Member
Special Committee on Transportation Security and Emergency Management	Herby Gerald Lissade	Maintenance	Member
Special Task Force on Data for Decisions and Performance Measures	Coco Briseno	Research, Innovation and System Information	Member
Standing Committee on Highway Traffic Safety	Jessie Bhullar	Traffic Operations	Member
Standing Committee on Highways	Karla Sutliff	Engineering Services	Member
Standing Committee on Performance Management	Coco Briseno	Research, Innovation and System Information	Member
Standing Committee on Planning	Kome Ajise	Executive	Member
Standing Committee on Public Transportation	Jila Priebe	Mass Transportation	Member
Standing Committee on Public Transportation	Brian Travis	Planning	Member
Standing Committee on Public Transportation	Jane Perez	Mass Transportation	Member
Standing Committee on Rail Transportation	Emily Burstein	Information Services	Member
Standing Committee on Rail Transportation	Bill Bronte	Rail	Vice-Chair
Standing Committee on Research	Steve Takigawa	Executive	Member
Standing Committee on the Environment	Dale Jones	Planning	Member
Standing Committee on the Environment	Scott McGowen	Environmental Analysis	Member
Standing Committee on the Environment	Anmarie Medin	Environmental Analysis	Member
Standing Committee on the Environment	Gina Moran	Planning	Member
Standing Committee on the Environment	Jay Norvell	Environmental Analysis	Member
Statewide Transportation Data and Information Systems	Coco Briseno	Research Innovation and System Information	Member
Steel Bridges	Barton J. Newton	Engineering Services	Member
Structures	Mike Keever	Engineering Services	Member

Committee Title	Committee Member	Division	Committee Role
Subcommittee on Air Quality	Mike Brady	Planning	Member
Subcommittee on Air Quality	Pete Conn	Environmental Analysis	Member
Subcommittee on Bridges and Structures	Lian Duan	Research Innovation and System Information	Member
Subcommittee on Bridges and Structures	Susan Hida	Engineering Services	Non-voting Member
Subcommittee on Bridges and Structures	Mike Keever	Engineering Services	Non-voting Member
Subcommittee on Bridges and Structures	Barton J. Newton	Engineering Services	Member
Subcommittee on Community and Cultural Resources	Anmarie Medin	Environmental Analysis	Member
Subcommittee on Construction	Mark Leja	Construction	Member
Subcommittee on Design	Kevin Hanley	Design	Member
Subcommittee on Design	Richard D. Land	Executive	Vice-Chair
Subcommittee on Highway Transport	James Anderson	Traffic Operations	Member
Subcommittee on Information Systems	Ann Barsotti	Information Technology	Member
Subcommittee on Information Systems	Doug Kempster	Information Technology	Member
Subcommittee on Internal and External Audits	William Lewis	Audits and Investigations	Member
Subcommittee on Legal Affairs	Ron Beals	Legal	Member
Subcommittee on Maintenance	Tony Tavares	Maintenance	Member
Subcommittee on Materials	Phil Stolarski	Engineering Services	Member
Subcommittee on Natural Systems and Ecological Communities	Scott McGowen	Environmental Analysis	Member
Subcommittee on Organizational Management	Kevin Hanley	Design	Member
Subcommittee on Personnel and Human Resources	Cris Rojas	Administration	Member
Subcommittee on Public Affairs	Tamie McGowen	Public Affairs	Member
Subcommittee on Right-of-Way and Utilities	Rene Fletcher	Right of Way and Land Surveys	Member
Subcommittee on Right-of-Way and Utilities	Don Grebe	Right of Way and Land Surveys	Member
Subcommittee on Right-of-Way and Utilities	Brent Green	Right of Way and Land Surveys	Member
Subcommittee on Right-of-Way and Utilities	Suzette Shellooe	Right of Way and Land Surveys	Member
Subcommittee on Safety Management	Yin-Ping Li	Local Assistance	Member
Subcommittee on Safety Management	Thomas Schriber	Traffic Operations	Non-voting Member
Subcommittee on Safety Management	Jeanne E. Scherer	Legal	Member
Subcommittee on Systems Operation and Management	Monica Kress	Traffic Operations	Member
Subcommittee on Systems Operation and Management	Greg Larson	Research, Innovation and System Information	Member
Subcommittee on Systems Operation and Management	Lawrence H. Orcutt	Equipment	Member
Subcommittee on Systems Operation and Management	Joan Sollenberger	Planning	Member

Committee Title	Committee Member	Division	Committee Role
Subcommittee on Traffic Engineering	Janice Benton	Traffic Operations	Member
Subcommittee on Traffic Engineering	Robert Copp	Traffic Operations	Member
Subcommittee on Transportation Communication	Tamie McGowen	Public Affairs	Member
Subcommittee on Transportation Finance Policy	Norma Ortega	Finance	Member
Synthesis of Information Related to Airport Problems	Gary C. Cathey	Aeronautics	Member
Task Force on the Logistics of Disaster Response and Business Continuity	Herby Gerald Lissade	Maintenance	Member
Task Force on Understanding New Directions for the National Household Travel Survey	Sarah Chesebro	Planning	Member
Task Group for Urban Freeway Models Validation	Nicholas Compin	Planning	Member
Technology Implementation Group	Richard D. Land	Director's Office	Member
Tort Liability and Risk Management	Jeanne E. Scherer	Legal	Member
Traffic Flow Theory and Characteristics	Koohong Chung	Traffic Operations	Member
Transportation Asset Management	Coco Briseno	Research, Innovation and System Information	Member
Transportation History	Craig Copelan	Traffic Operations	Member
Transportation Law	Anthony Samson	Legal	Member
Transportation-Related Noise and Vibration	Bruce Rymer	Environmental Analysis	Member
Travel Survey Methods	Sarah Chesebro	Planning	Member
Work Zone Traffic Control	Theresa Drum	Maintenance	Member

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