Pavement Research Roadmap (2011 - 2014)
Caltrans Division of Research & Innovation and UC Pavement Research Center

Roadmap for Pavement Research

Vision *Pavement research improves mobility across California by finding ways to deliver pavement projects more efficiently, preserving pavement assets through longer service life, reducing environmental impact through smoother pavements and reduced maintenance, and providing the safest transportation system in the nation.*

Mission Provide implementable research results enabling new and innovative business practices that span the Department's functional program areas through enhanced designs, materials, specifications, methods, tests, equipment, manuals, policies, and procedures.

	CALTRANS PROGRAM AREAS							
	DESIGN, MATERIALS & ENVIRONMENTAL				CONSTRUCTION		MAINTENANCE	
PRIORITY TOPICS	**Mechanistic-Empirical Design**	**Improving Pavement Performance**	**Recycling and Sustainability**	**Quiet Pavement**	**Construction Practices and Project Delivery**	**Smoothness**	**Preservation**	**Pavement Management**
STRATEGIC PROBLEMS	Reducing life cycle costs of pavements requires the ability to predict pavement performance more accurately than is possible with Caltrans' traditional design and analysis methods.	Congestion, increased travel times, and accidents associated with frequent construction and maintenance activities have become more prevalent with increases in population.	Decreasing availability of high quality material sources for pavement construction requires innovative methods of reusing or recycling sound, in-place materials.	Public perception is that noise levels from vehicle tire/pavement sources is unacceptable and could be made quieter for a better quality of life.	Construction activities on near-capacity highways led to a need for shorter duration lane closures and higher efficiency of construction, which would reduce negative impacts on the public, goods movement, and the environment.	Perception by the public is that pavements as currently constructed and maintained within California often provides an unacceptably poor ride quality.	Pavement preservation techniques are not well understood within the transportation industry and state-of-the-art standards are nonexistent.	Data, on pavement infrastructure and performance, are not available to enable faster pavement improvements and innovations.
STRATEGIC OBJECTIVES	Develop Mechanistic-Empirical (ME) methods, based on theories of mechanics, that can enable more accurate predictions leading to optimized pavement performance and lower life cycle costs.	Design and construct pavements with higher quality control and pavement characteristics that provide longer service lives and reduce congestion from recurring maintenance and rehabilitation work.	Develop and promote high quality pavement recycling techniques (both hot and/or cold) in order to preserve and enhance California's resources and investments.	Construct and maintain quieter pavements in order to preserve and enhance California's resources and investments.	Provide methods and tools for faster construction (prefabrication, new techniques, new materials, composite pavements) in order to improve delivery of projects and services by Caltrans.	Construct and maintain smoother pavements in order to optimize transportation throughput and provide dependable travel times as well as providing the safest transportation system in the nation for users and workers.	Use pavement preservation techniques and guidance, including development of a center of excellence for training and research in order to preserve and enhance California's resources and investments.	Develop a true Pavement Management System (PMS) to track pavement innovation, pavement structure and performance over time in order to preserve and enhance California's resources and investment.
RESEARCH APPROACH	After committing in 2005 to transitioning to ME, Caltrans has implemented a first version of ME design for concrete pavements. Further research is needed to enhance this tool and to develop and implement an ME design tool for asphalt pavements. Research includes developing models, climate and materials databases, seasonal adjustments, sensitivity analyses, calibrating models with field data, developing simple design tools, and assisting with implementation.	Development of long life pavements requires innovative designs, materials, and construction followed by monitoring of pavement condition to evaluate short- and long-term performance. Results from monitoring provide validation and further calibration data to realize cost-efficient, long-life designs of major urban corridors. Projects also provide data to help implement ME and validate innovative construction practices.	High quality pavement recycling will be improved over several years. Research will identify the most promising recycled materials through literature review and laboratory testing, evaluating techniques (both hot and cold) developed by other organizations and Caltrans' experience, then followed by HVS validation before evaluation in pilot projects. Implementation will require validation of proposed changes and training Caltrans and contractor personnel.	Research over the next several years will develop new design, construction, and maintenance approaches to quiet pavements. FHWA's 2005 policy requires multiple years of monitoring "quieter pavements". Laboratory testing and development of new asphalt surface mixes aim to optimize pavement ride quality, noise, pavement permeability and durability properties. Future implementation of new mix designs will follow field testing, calibration and validation.	Development of tools that analyze construction, e.g. CA4PRS software, now make it possible to determine optimal construction work schedules in a fraction of the time than traditional methods. Research will further enable reducing construction duration, impacts, cost, and traffic delay by streamlining pavement construction schedules, improving planning, and exploring new materials and specifications.	New equipment for measuring smoothness will be evaluated and may have to be procured. Specifications and procedures will be studied and developed. Resources to maintain, calibrate, and use new equipment will be required. Construction pay factors may require adjustments. This topic is supported by research on Quiet Pavements and Composite Pavement Systems (*Strategic Highway Research Program*, project SHRP R-21).	Pavement preservation research will quantify and correlate pavement circumstances (age, condition, climate zone and traffic load) to a suitable recommended course of preservation treatment. Research will include laboratory testing, analysis, and HVS tests. Best practice for treatment selection and timing for different conditions will be determined from current and future research.	A true PMS will require changes in equipment, data collection, analysis (amount, capabilities, & automation), particularly for as-built and condition survey data. The database will continue to be modified to improve management of the network. Expansion of the database and adjustments to the PMS will be used to further calibrate ME design and analysis. Adjustments to Life Cycle Cost Analysis will be validated in case studies and integrated into decision processes for pavement management.

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PROJECT TITLES and descriptions	• **Coefficient of Thermal Expansion in PCC Pavement Design and Specification (SPE 4.30, TID 2310)** - Assess the significance of CTE on early and longer-term cracking performance to determine how CTE should be considered in design and materials specifications for use in PCC pavements in California. • **Early-Age Cracking Performance (SPE 4.32, TID 2352)** - Identify potential causes and develop appropriate design parameters and/or construction procedures to limit or prevent early age cracking in PCC pavements. • **Updated Standard Materials Library (SPE 3.18, TID 2356)** - Update the state asphalt materials library with new materials (e.g. cold-foam, cement stabilization, RHMA, etc.)	• **Life-Cycle Cost and Environmental Life-Cycle Analysis for Composite Pavements (SPE 3.20, TID 2371)** - Incorporate the life-cycle cost and environmental life-cycle assessment of composite pavements into Caltrans documents.	• **Recycling of RHMA in RAP and Full-Depth Reclamation Projects for both Hot and Warm Mix Technologies (SPE 4.36, TID 2374)** - Develop guidelines and recommendations for using RHMA in RAP and recycling it into new pavement layers in full-depth (FDR) and partial-depth reclamation (PDR) projects. The guidelines will include hot and warm mix technologies. • **Use Environmental Life Cycle Assessment to Develop Simplified Tools and Recommend Practices to Reduce Environmental Impact of Pavements (SPE 4.37, TID 2376)** - Identify network and project-specific practices for pavement design, materials selection, traffic handling, and maintenance and rehabilitation practices that will reduce environmental impact and use of finite resources. Develop approach to consider agency costs with environmental impact, through development of a multi-criteria decision making process.	• **Implementation of New Quieter Pavement Research (SPE 3.21, TID 2380)** - Develop specifications, guidelines, standardized laboratory and field test methods and other information needed to incorporate quieter pavement research into standard Caltrans practice. • **Continued Monitoring of Selected Quieter Pavement Test Sections (SPE 4.39, TID 2375)** - Complete data sets to failure for concrete and asphalt quieter pavement and experimental test sections that remain in service. Data will be used in the proposed project "Acoustical Longevity of Noise Reducing Pavement".	• **Environmental Impacts and Energy Efficiency of Warm Mix Asphalt (SPE 4.41, TID 2366)** - Quantified environmental benefits of using warm-mix asphalt technologies. Funded by CalRecycle.	• **Certification of Inertial Profilers used in PMS and Construction Monitoring (SPE 3.24, TID 2364)** - Develop a certification procedure and establish a facility for certifying/calibrating inertial profilers in California. • **Effects of Milling and Other Repairs on Smoothness of Thin Overlays (SPE 4.42, TID 2363)** - Develop guidelines and revised specifications for pre-overlay treatments and smoothness for thin overlays.	• **Improved Methodology for Mix Design of Open-Graded Friction Courses (SPE 3.25, TID 2362)** - Develop guidelines, revised test procedures, and revised specifications for mix design of open-graded friction courses.	• **Performance Modeling (SPE (4.43, TID 2358)** - Develop new and refine existing performance prediction models for California. Develop initial estimates of future condition using models. • **Update Life-Cycle Cost Analysis Manual with New Performance Data (SPE 3.27, TID 2357)** - Prepare updated default data for Caltrans LCCA manual. • **Complete QA on Automated Pavement Condition Survey and GPR contracts (SPE 3.28, TID 2354)** - Quality assurance on the automated pavement condition survey and GPR contracts.

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PROJECT UPDATES **Quarter 3** **01/01/13 to 03/31/13**	• **Coefficient of Thermal Expansion in PCC Pavement Design and Specification (SPE 4.30, TID 2310)** - Finished draft workplan for round robin study. Calibration specimen at UCPRC sent for independent check. • **Early-Age Cracking Performance (SPE 4.32, TID 2352)** - Started working on literature review of rapid strength concrete performance. • **Updated Standard Materials Library (SPE 3.18, TID 2356)** - Aggregates prepared for 5 of 7 mixes. HMA specimens prepared for three mixes and testing being conducted on second mix. Testing delayed due to reprioritization of Solano 80 (3.18.2) laboratory testing ahead of this SPE due to construction deadline. - Significant shear and fatigue laboratory mix testing for Teichert Solano I-80 was conducted for mix design. SR299 removed from ME Long Life project list and Materials Library. - Phase 1 Tech Memo has been completed and is under Caltrans review. Phase 2 specimen preparation underway with HMA specimens produced for 3 mixes and aggregate for five mixes. AMPT field and lab cores being prepared for pilot study comparing AMPT and RSST performance.	• **Life-Cycle Cost and Environmental Life-Cycle Analysis for Composite Pavements (SPE 3.20, TID 2371)** - LCA work dropped due to budget transfer. Composite pavement design and LCCA inputs developed and documented in the technical memorandum. .	• **Recycling of RHMA in RAP and Full-Depth Reclamation Projects for both Hot and Warm Mix Technologies (SPE 4.36, TID 2374)** - Continued with literature review and site visit planning. Started HVS testing at end of January. Completed first test (±720,000 repetitions) on the unstabilized control section. Moved equipment to the FDR-FA section. Continued laboratory testing, which includes compaction of test specimens, curing, and unconfined compressive strength and indirect tensile strength testing. • **Use Environmental Life Cycle Assessment to Develop Simplified Tools and Recommend Practices to Reduce Environmental Impact of Pavements (SPE 4.37, TID 2376)** - Completed draft version of report on analysis of state network for GHG emissions and energy from paving rough segments and effect of smoothness on driver speed. Continued work on lane reconstruction. Began work on implementation of energy dissipation models and traffic closure effects. - Began setting up sub-contract for PEI and sub-contract to LBNL	• **Implementation of New Quieter Pavement Research (SPE 3.21, TID 2380)** - Summarizing data and preparing the PCC report. - Draft summary report on HMA being reviewed by editor and PI. • **Continued Monitoring of Selected Quieter Pavement Test Sections (SPE 4.39, TID 2375)** - Received draft report from Illingworth and Rodkin and distributed for comment. - Nearly completed Phase 4 PCC Noise section have been tested. - Continued field sampling of PCC textures.	• **Environmental Impacts and Energy Efficiency of Warm Mix Asphalt (SPE 4.41, TID 2366)** - Completed reports on R-HMA/R-WMA. Continued laboratory fume generation and analysis of collected gases. Started preparation of reports on binder aging, emissions, and new OGFC design testing.	• **Certification of Inertial Profilers used in PMS and Construction Monitoring (SPE 3.24, TID 2364)** - Prepared draft of the Inertial Profiler Certification Specifications and reviewed with Caltrans. Surveyed and marked the calibration test sections at Sacramento RT station. Began establishing baseline profile measurements with reference profiler. UCPRC operator and car were sent to Texas in November and certified. • **Effects of Milling and Other Repairs on Smoothness of Thin Overlays (SPE 4.42, TID 2363)** - Completed draft report and sent to editor. Continued testing construction sites as requested by Caltrans.	• **Improved Methodology for Mix Design of Open-Graded Friction Courses (SPE 3.25, TID 2362)** - Completed all the draindown, Cantabro, and HWTD tests for 10 mix types. Finished developing the Excel macro for (1) volumetric design and (2) performance testing of OGFC mix design.	• **Performance Modeling (SPE (4.43, TID 2358)** - Completed validation of PaveM implementation. Prepared models section of engineering configuration summary report. • **Update Life-Cycle Cost Analysis Manual with New Performance Data (SPE 3.27, TID 2357)** - The additional tasks requested by Caltrans in January were completed on schedule. (multiple selections of alternatives in M&R selection, annual maintenance cost for alternative, comprehensive report function, and enhancement of cost estimate). The second additional task plan developed for quality support for RealCost, Manual, and Training and approved ($35K for four months until June 2013). • **Complete QA on Automated Pavement Condition Survey and GPR contracts (SPE 3.28, TID 2354)** - Continued to receive and load data, and pass data to Caltrans for PaveM. - Received all data for Task Order 2 (2012) and checked them. Continued to work with Fugro on fixing post-mile issues. - All FVS field data has been collected. Not much progress while data continues to be redelivered. - Conducted a study per Caltrans in order to see if there were viable options to reduce the number of segments without negatively impacting optimization and project selection. - Completed work on iGPR-Core (web application to allow District/Construction folks to upload core data for viewing within iGPR). Assisted Caltrans in making changes to PaveM encoded configurations (SQL scripts). Reviewed new version of Caltrans' LRS and provided corrections back to Caltrans. Wrote a Tech Memo (UCPRC-TM-2013-02) detailing and summarizing the engineering configuration in PaveM. This Tech Memo is a companion document to the detailed engineering configuration

For information on past research projects, visit (Caltrans) http://www.dot.ca.gov/research/researchreports/index.htm and (PPRC) http://www.ucprc.ucdavis.edu
For additional information on Caltrans Pavement Research Program, email Nick Burmas, Office Chief of Materials and Infrastructure at nick.burmas@dot.ca.gov