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 HIGHLIGHTS (new contract 2011-14)	• **Coefficient of Thermal Expansion in PCC Pavement Design and Specification (SPE 3.1)** - 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. • **New Approach to the Prediction of Fatigue Damage in PCC (SPE 3.2)** - To develop a model for the prediction of damage evolution in concrete type pavements based on the fundamentals of fracture. • **Early-Age Cracking Performance (SPE 3.3)** - Identify potential causes and develop appropriate design parameters and/or construction procedures to limit or prevent early age cracking in PCC pavements. • **Differences in Fatigue Performance of Mixes with Same PG Binder Grade (SPE 3.6)** - Quantify the effects of the binder source on fatigue performance of Caltrans mixes and develop guidelines to take into account binder source effects on HMA mix design in Caltrans HMA specifications and designs. • **Updated Standard Materials Library (SPE 3.8)** - Update the state asphalt materials library with new materials (e.g. cold-foam, cement stabilization, RHMA, etc.) • **Interlayer Performance (SPE 3.10)** - Develop interlayer performance models and interlayer use guidelines.	• **Life-Cycle Cost and Environmental Life-Cycle Analysis for Composite Pavements (SPE 4.4)** - Incorporate the life-cycle cost and environmental life-cycle assessment of composite pavements into Caltrans documents.	• **Use of Higher Quantities of RAP and RAP Warm-Mix Interactions (SPE 5.1)** - Develop guidelines and recommendations for using increased RAP quantities in Caltrans mix designs. • **Recycling of RHMA in RAP and Full-Depth Reclamation Projects for both Hot and Warm Mix Technologies (SPE 5.2)** - 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 5.5)** - 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 6.1)** - Develop specifications, guidelines, standardized laboratory and field test methods and other information needed to incorporate quieter pavement research into standard Caltrans practice. • **Acoustical Longevity of Noise Reducing Pavement (SPE 6.2)** - Develop models for pavement acoustics for use in the PMS, LCCA, and by district and HQ managers and engineers. • **Continued Monitoring of Selected Quieter Pavement Test Sections (SPE 6.3)** - 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".	• **Performance Based Specifications for Pavement Preservation Treatments (SPE 7.1)** - Develop performance related specifications for pavement preservation treatments currently included in Caltrans practice and described in the Maintenance Technical Advisory Guide (MTAG). • **Effects of WMA Technologies on Binder Aging (SPE 7.3)** - Develop revised HMA, RHMA-G and RHMA-O performance models that take the effects of different binder aging behavior related to the use of warm-mix asphalt into consideration. • **Environmental Impacts and Energy Efficiency of Warm Mix Asphalt (SPE 7.8)** - Quantified environmental benefits of using warm-mix asphalt technologies. • **Evaluation of Compacted HMA Moisture Sensitivity (SPE 7.9)** - Develop data relating laboratory mix moisture sensitivity to field performance. Prepare revised guidelines, test methods, limits, and specifications for moisture sensitivity testing.	• **Certification of Inertial Profilers used in PMS and Construction Monitoring (SPE 8.2)** - 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 8.3)** - 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 9.1)** - Develop guidelines, revised test procedures, and revised specifications for mix design of open-graded friction courses. • **Use of Terminal Blend Rubber Binders in Preservation Overlays (SPE 9.2)** - Develop guidelines, revised test methods, and revised specifications for use of terminal blend rubber binders in preservation overlays.	• **Performance Modeling (SPE (10.1)** - 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 10.2)** - Prepare updated default data for Caltrans LCCA manual. • **Complete QA on Automated Pavement Condition Survey and GPR contracts (SPE 10.3)** - Quality assurance on the automated pavement condition survey and GPR contracts.

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