Pavement Research Roadmap (2014 - 2017)
Caltrans Division of Research, Innovation and Systems Information
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 & CONSTRUCTION			ENVIRONMENTAL		MAINTENANCE	
PRIORITY TOPICS	**Mechanistic-Empirical Design**	**Performance Based Specifications**	**Construction Quality**	**Recycling**	**Sustainability**	**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.	Current recipe-based specifications place most of the risk on Caltrans and don't allow for innovations.	Construction activities on near-capacity highways led to a need for shorter duration lane closures and high quality construction, which would reduce negative impacts on the public, goods movement, and the environment.	Decreasing availability of high quality material sources for pavement construction requires innovative methods of reusing or recycling sound, in-place materials.	Constructing and maintaining pavements have environmental impacts that must be assessed and reduced.	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 and implement 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 specifications that assure longer service lives and reduce congestion from recurring maintenance and rehabilitation work.	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. Design and construct pavements with higher quality control and pavement characteristics that provide longer service lives.	Develop and promote high quality pavement recycling techniques for all kinds of pavement in order to preserve and enhance California's resources and investments.	Identify and quantify the environmental impacts of various construction and maintenance activities.	Use pavement preservation techniques and guidance 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. An ME design tool for asphalt pavements has been developed and is being implemented. Research includes developing new models and improving current ones, improvement of climate, materials and traffic databases, seasonal adjustments, sensitivity analyses, calibrating models with field data, improving 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. Identify the parameters that lead to long-term pavement performance. Develop new performance based tests and specifications, including consideration of new materials and methods of quality assurance, using HVS validation where warranted before evaluation in pilot projects. Support transfer of capability to industry and the Department.	Research various construction planning (e.g. imaging) and techniques (e.g. precast, improved materials) that will further enable reducing construction duration, impacts, cost, and traffic delay by streamlining pavement construction schedules, improving planning, and exploring new materials and specifications.	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 developed by other organizations and Caltrans' experience, using HVS validation where warranted before evaluation in pilot projects. Implementation will require validation of proposed changes and training Caltrans and contractor personnel.	Work with industry and other state agencies to identify and quantify environmental impacts (e.g. green-house gases, noxious gases, storm-water runoff, energy consumption, etc.) of construction and maintenance activities. Develop tools that will allow designers to assess the environmental impacts of various pavement work alternatives.	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 where warranted. Best practice for treatment selection and timing for different conditions will be determined from current and future research.	A true PMS is being implemented by the Department. Continue to support improvements in collection and use of 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 improve performance models and treatment selection approaches, and 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 description	• **Standard Materials Library and Guidance (SPE3.30, TID 2667)** - Test and include additional regional materials in the Caltrans ME Standard Materials Library, including base, subbase and new recycled materials. Implement procedures to simplify the selection of material types for ME design by district designers, and develop guidance for asphalt mix designers to meet performance related mix design requirements. Support implementation of CalME and use of MEPDG. • **Improved ME Design and Reliability Approach (SPE 3.31, TID 2668)** - Improve the ability/reliability of Caltrans and national ME procedures to predict pavement distresses. Address upcoming changes in AASHTO test methods for asphalt fatigue cracking and translation of data from repeated shear to the new Asphalt Material Performance Tester (AMPT) equipment. Update calibration of Mechanistic-Empirical Pavement Design Guide (MEPDG) methods for jointed plain concrete (JPC) transverse cracking and faulting using new condition survey data. Complete study investigating range of coefficient of thermal expansion (CTE) values in state testing procedures.	• **Performance-Related Specifications for Rubberized Asphalt Binder (SPE 4.50, TID 2671)** - Develop supporting data/information for the writing of performance related QC/QA specifications for mix design and mix placement of terminal blend and wet process asphalt rubber mixes. This project will use recently developed dynamic shear rheometer (DSR) test methods for assessing rubber binders and will include laboratory mix tests and field evaluations on new and recent projects. • **Support for Superpave Implementation (SPE 3.32, TID 2672)** - Establish annual state-wide round robin (to be taken over by METS IA program) for Hamburg Wheel Track Test (HWTT) study to determine precision and bias, and incorporate results in revised specifications. Assess differences between laboratory and plant produced mix, and continued development and implementation of performance related tests. Review appropriateness and applicability of QC/QA testing on Superpave projects and make recommendations for revised specifications if justified. Monitor performance of Superpave projects constructed to date. • **Simplified Performance Based Specifications for AC Long Life Projects (SPE 3.33, TID 2673)** - Complete the development of simplified asphalt mix design procedures and specification preparation for AC long life projects that are easier for contractors and districts to understand and communicate on, but do not increase the risk of poor performance to Caltrans. Evaluate revised specifications and procedures on new AC long life projects. Support Caltrans on implementation and training. • **Improved Screening Tests for Alkali-Silica Reaction (SPE 3.34, TID 2702)** - Evaluate Caltrans historical risk for ASR for pavements and structures. Determine appropriate testing methods and criteria for assuring Caltrans low risk.	• **Quieter Pavement Long-term Monitoring (SPE 3.35, TID 2710)** - Continue noise, smoothness (IRI), and friction monitoring of a few selected grind and groove (GnG) and continuously reinforced concrete pavement (CRCP) pilot sections for which monitoring began in 2012/13.	• **Binder Replacement in High RAP/RAS Asphalt Mixes (SPE 4.51A&4.51B, TID 2676&2677)** - Continuation of a study investigating determination of binder replacement rates in high RAP/RAS mixes without the need for binder extraction. This is a phased study starting with binder testing and analyzing, followed by laboratory mix and field testing, and then APT if justified. The effects of asphalt modifiers (polymer and rubber), warm mix technologies, and rejuvenators will also be investigated. • **Improved Guidance and Specifications for Full-Depth Reclamation (SPE4.59, TID 2707)** - Continuation of a study to develop project selection and design guidelines and specifications for different full-depth reclamation (FDR) strategies. This phase of the project will assess performance of different FDR stabilization treatments under wet conditions using accelerated pavement testing on existing test sections. This phase will also monitor performance of completed field projects that used the different strategies, including comparing as-built properties with laboratory design properties. • **Microcracking for Cement Stabilized Layers (SPE 4.52A&4.52B, TID 2708&2709)** - Develop laboratory design and construction procedures/specifications for microcracking/ precracking of new or in-place recycled cement stabilized layers to limit the effects of shrinkage related cracking, taking into consideration material properties, climatic factors, and cement contents. Consider interactions of different cement contents with microcracking and layer thickness design.	• **Validation of Greenhouse Gas Emissions from Pavement Deflection (SPE 4.53, TID 2691)** - Follow up to 13/14 project to review mechanistic equations from MIT and other research centers to calculate viscoelastic energy dissipation from vehicle operation for different pavement types, climate regions and vehicle types. Perform field validation of fuel economy differences, compare results with researchers, and then perform comprehensive assessment for state network implementation. • **Environmental Life Cycle Assessment Updates and Applications (SPE 4.54, TID 2718)** - Address additional issues required for Caltrans to meet AB32 greenhouse gas emission targets and category pollutant regulations using environmental life cycle analysis (LCA) following the Pavement LCA Roadmap. Develop additional/improved methods for LCA for the range of design, construction, maintenance, and rehabilitation strategies used in California. • **Updated Greenhouse Gas Emission Evaluations (SPE 4.55, TID 2719)** - Update Greenhouse Gas Emission methodologies for pavement management based on validation and calibration of LCA methods for pavement effects on vehicle emissions, including results of proposed projects Sus-A and Sus-B. Provide recommendations for improved simplified LCA GHG evaluations.	• **Effects of Pavement Roughness on Freight Movement (SPE4.56, TID 2723)** - Continue study to assess effects of roughness on cost of freight transport, choice of routes by haulers, and on emissions. Additional types of freight, districts, and routes will be assessed. • **Guidelines for Preservation Treatments for Bicycle Routes (SPE 4.57, TID 2693)** - Use results of recent cyclist comfort study for chip seal textures to test more Caltrans treatments for texture, and prepare guidelines for selection of preservation treatments that can be used on bicycle routes on state highways. • **Evaluate Early Age and Premature Cracking for LCCA (SPE 4.58, TID 2713)** - Complete work evaluating early age and premature cracking of slab replacements and concrete lane replacements to determine risks and likely causes of failures, to develop recommendations for reducing risks. Prepare design life estimates for use in LCCA.	• **Evaluate Traffic Speed Deflection Measurement (SPE 4.60, TID 2686)** - In conjunction with an FHWA pooled fund study on traffic speed deflection measurements, determine whether this method of pavement structural condition assessment is appropriate/will add value to network level assessments in California. • **Improved Smoothness and Distress Models and Benefits Equations for PaveM (SPE 5.01, TID 2703)** - Develop performance models for pavement smoothness and distresses based on the percentage of segment worse than the threshold values instead of the current approach, which uses average condition values. Review impact of these models on calculation of benefits. • **Performance Models for Seal Coats in PaveM (SPE 5.02, TID 2674)** - Develop pavement distress performance models for specific preservation treatments currently grouped under “Seal Coat” to provide more detailed treatment selection in PaveM, including slurry seals, aggregate seal coats with different binders and gradations, fog seals, and others identified by Caltrans. • **Evaluate Composite Pavement Performance and Decision Trees (SPE 5.03, TID 2704)** - Evaluate performance of composite pavements built in California (typically performed as crack, seat and overlay) to determine whether they should have a separate decision tree in PaveM. • **Algorithms for Grouping Segments into Projects in PaveM (SPE 5.04, TID 2705)** - Complete development of an algorithm to combine multiple management segments selected for treatment into potential construction projects and design graphic user interface for coding in PaveM. • **New Life Cycle Cost Optimization Models for PaveM (SPE 5.05, TID 2687)** - Apply new life cycle cost optimization models to PaveM decision trees. Use results to advise the implementation and evaluation of incremental benefits (Inc-Ben) option in PaveM software by Caltrans. • **Evaluate APCS Data Collection and PaveM Engineering Configuration (SPE 5.06, TID 2688)** - Evaluate how distresses collected by the Automated Pavement Condition Survey (APCS) are being used in PaveM decision trees and develop recommendations for changes in APCS and/or decision trees, performance equations and benefits equations. • **Evaluate Linear Reference System (SPE 5.07, TID 2722)** - Compare Caltrans’s current Linear Reference System (LRS) with approaches used by other states and system needs for MAP-21, and identification of pros and cons of retaining current system or changing to a county and state odometer system. • **Document PaveM Traffic Updating Processes (SPE 5.08, TID 2706)** - Document processes for updating traffic used in PaveM and in bridge and pavement design. The study will also characterize truck traffic with unregulated loads for ME design for state highways near heavy load facilities. • **Update PaveM Engineering Configuration (SPE 5.09, TID 2689)** - Update engineering configuration (data aggregation, decision trees, benefit equations) as experience is gained during initial use by districts and HQ. Address additional data collection, materials design and policy questions developed by Caltrans. • **Update Guidance and Calculations for Life Cycle Cost Analysis(SPE 5.10, TID 2690)** - Develop LCCA information and guidance for new pavement structures, rehabilitation and preservation treatments. • **Update project level asphalt surface design (SPE 3.36 TID 2675)** - Update California mechanistic-empirical project level pavement management design method and process.