Long-Term Plan for Concrete Pavement Research and Technology:

The CP Road Map

An Executive Summary

Draft Copy November 19, 2004

U.S. Department of Transportation
Federal Highway Administration

CENTER FOR
PORTLAND CEMENT CONCRETE
PAVEMENT TECHNOLOGY

IOWA STATE UNIVERSITY

Introducing a new, comprehensive, and strategic plan for concrete pavement research: the CP Road Map. The CP Road Map will guide the investment of research dollars for the next several years. It will result in technologies and systems that help the concrete pavement community meet the paving needs of today, and the as-yet unimagined paving challenges of tomorrow.

In short, the CP Road Map will result in a new generation of concrete pavements for the 21st century.

This booklet briefly describes the CP Road Map and the innovative Research Management Plan.

What's Unique about the CP Road Map?

This plan is indeed strategic, combining more than 250 research problem statements into 12 fully integrated, sequential, cohesive tracks of research leading to specific products that will dramatically affect the way concrete pavements are designed and constructed.

It is innovative. From the way the CP Road Map was developed, to its unique track structure and cross-track integration, to the plan for conducting the research, it introduces a new, inclusive, and far-reaching approach to pavement research.

It belongs to stakeholders. Whether you're part of the Federal, State, or private concrete pavement community, the CP Road Map is *your* plan. Your peers helped create it, so it reflects your needs.

It is not bound by cost or time limitations. In general, it is a 7- to 10-year plan with an estimated overall cost of $250,000,000.

It is not tied to any one agency or pot of money. Stakeholders with funds and expertise will pool their resources, jointly conduct and coordinate the research, and put the results into practice.

It incorporates innovative, effective research implementation to quickly move useful new products and systems to the field.

Project history and team

The project to develop the Long-Term Plan for Concrete Pavement Technology began in 2001, through an agreement between the Innovative Pavement Research Foundation and a team led by Iowa State University's Center for Portland Cement Concrete Pavement Technology (the PCC Center). In May 2003, the Federal Highway Administration initiated a new agreement with the PCC Center to complete the work under a Concrete Pavement Technology Program contract (Task 15). The TRB Committee for Research for Improved Concrete Pavements acted as the project advisory panel. Twenty percent of total funding for the project was provided by Iowa State University.

A Visionary Charge

In 2001, the Federal Highway Administration (FHWA) and the concrete pavement industry had the foresight to commission a national research plan. Why is such a plan needed?

For most of the 20th century, the same materials—portland cement, high-quality aggregate, and water—were used in concrete for pavements, with only minor refinements. It was a fairly forgiving formula that allowed some variations in subgrade quality, construction practices, and other variables without sacrificing pavement performance. For generations, too, the industry had the luxury of keeping traffic off new concrete pavements for several days, even weeks, while the concrete developed its internal design strength.

In the last 15 years, the industry has experienced more changes than occurred in the previous 80, and these changes are turning the process of building concrete pavements on end:

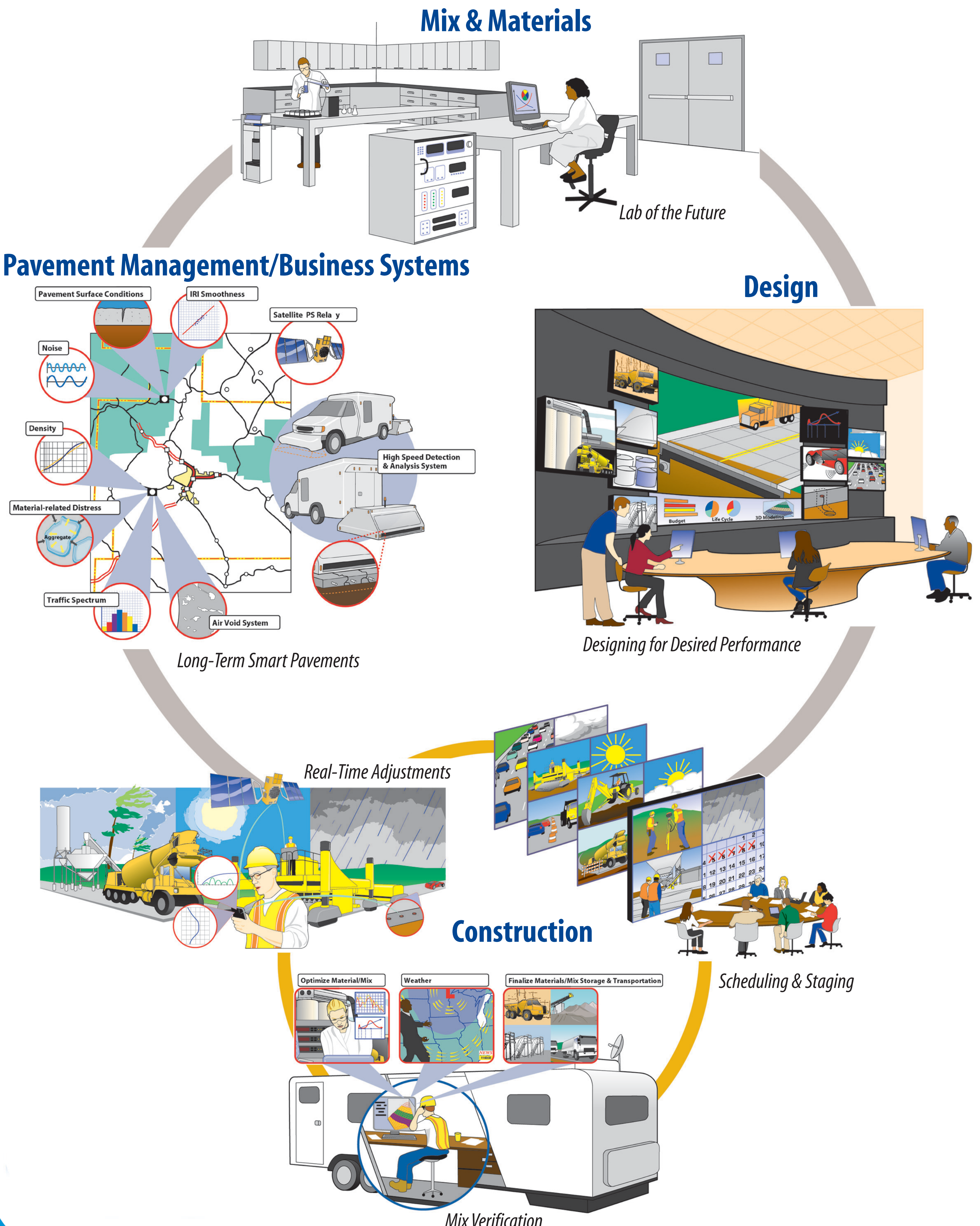
- Today's concrete mix designs must integrate a plethora of new, sometimes marginal materials, resulting in serious compatibility problems and reduced tolerance for variations.
- Motorists are more demanding. They will tolerate only minimal road closures and delays due to road work, increasing the need for new paving methods that allow road crews to get in, get out, and stay out. And motorists want smoother, quieter pavements, pushing the industry to control pavement surface characteristics.
- Highway agencies' focus has shifted from building new pavements to rehabilitating and maintaining existing ones, which requires different designs, systems, and equipment.
- Environmental pressures—traffic congestion, drainage and runoff issues, etc.—are affecting mix designs and pavement construction practices.
- Highway budgets are being squeezed at every level. The pavement community simply has to do more with less.

In this environment, the old system for constructing concrete pavements simply doesn't work anymore. Pavement failures have occurred that were unheard of 25 years ago.

To achieve concrete pavement's full potential in the new world order of highway transportation, the concrete pavement community cannot continue business as usual. The CP Road Map gives the community a once-in-a-lifetime opportunity to proactively reinvent itself through research.

CP Road Map Vision

By 2015, the highway community will have a comprehensive, integrated, fully functional system of concrete pavement technology that provides innovative solutions for customer-driven performance requirements.



Drawing a New Map for Concrete Pavements

An Iowa State University–led team facilitated development of the CP Road Map. They developed a database of existing research. They gathered input, face to face, from the highway community. They identified gaps in research that became the basis for problem statements, which they organized into a cohesive, strategic research plan.

A "living" research database

The research database is a thorough catalog of recently completed and in-progress research projects and their products. If regularly updated and maintained, as recommended in the Research Management Plan (described later in this brochure), it will be a valuable resource for many years.

Stakeholder input

To ensure the adoption and success of the CP Road Map, it was developed through a cooperative process involving unprecedented stakeholder teamwork.

Five major brainstorming-and-feedback events were conducted at the following venues: an annual meeting of the Midwest Concrete Pavement Consortium, a regional workshop for Eastern/Southern stakeholders, a national workshop for industry stakeholders, a regional teleconference with Western States, and a final meeting of stakeholders hosted by FHWA at the Turner-Fairbank Highway Research Center.

Through these events, plus special presentations at more than 20 professional conferences and workshops across the country, more than 400 engineers and managers provided direct input into the CP Road Map. Participants represented:

- State and local departments of transportation.
- FHWA.
- American Concrete Pavement Association, including several State chapters.
- Portland Cement Association.
- American Association of State Highway Transportation Officials.
- National Ready Mixed Concrete Association.
- Transportation Research Board /National Cooperative Highway Research Program Committees.
- American Public Works Association.
- National Association of County Engineers.
- Contractors.
- Materials suppliers.
- Research universities, especially departments conducting applied research.
- Private concrete testing laboratories.

Input was provided in four broad categories:
(1) Mixtures and materials.
(2) Design.
(3) Construction.
(4) Pavement management/business systems.

Again and again, stakeholders said they needed more and better analysis tools for measuring the hows and whys of pavement failures and successes—that is, to measure pavement performance. Better quality assurance and quality control methods/tools are needed for every stage of the pavement system, particularly mix design, design, and construction. Because variables in each stage affect the others, the methods/tools must be integrated across stages.

From these concepts of "pavement performance" and "systems integration," an overall vision for the CP Road Map was developed:

> *By 2015, the highway community will have a comprehensive, integrated, fully functional system of concrete pavement technology that provides innovative solutions for customer-driven performance requirements.*

Based on this goal and other stakeholder input, dozens of specific research objectives were identified. These objectives are summarized as follows:

- Maximize public convenience.
- Improve the driving experience.
- Integrate design, mix and materials, and construction with pavement performance prediction.
- Improve pavement reliability.
- Identify new and innovative business relationships to focus on performance requirements.
- Constrain costs while improving pavement performance.
- Protect and improve the environment.
- Expand opportunities to use concrete pavement.

The objectives were "filtered" through the project team's database of existing research to determine gaps in research. These gaps became the basis for problem statements.

Approximately 250 problem statements were written, reviewed, and finetuned. Final versions of the problem statements were added to the research database as work to be accomplished via the CP Road Map.

From input to plan

Most of the 250-plus problem statements did not neatly fit into just one of the brainstorming categories (mix and materials, design, construction, and pavement management/business systems). To capture the cross-category, integrated nature of the problem statements, they were organized into 12, product-focused tracks of research. This structure encourages various stakeholder groups to step forward as track "champions."

About problem statements

Each problem statement is a topical summary only. Most problem statements will be further broken down into specific research project statements that describe in detail the research to be accomplished. This will be the responsibility of research track team leaders under the Research Management Plan, described later in this document.

Track integration

As noted in the brief track descriptions on pages 6-9, research in one track often affects or is affected by research in another. In the CP Road Map, these and other critical relationships are clearly outlined in the track and problem statement descriptions. It will be the responsibility of research track team leaders, as described later in this document, to ensure that research is appropriately coordinated and integrated.

What about foundations? pavement maintenance? environmental challenges? The research database can be sorted to isolate problem statements on a variety of subjects. For example, several important problem statements related to foundations and drainage systems, maintenance and rehabilitation, and environment advancements are included in various tracks. In the CP Road Map, problem statements related to these particular topics have been listed in separate cross-reference tables.

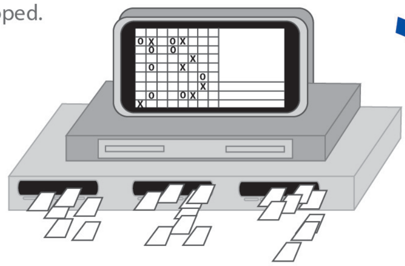
Database management: Re-charging the "brain" of the CP Road Map

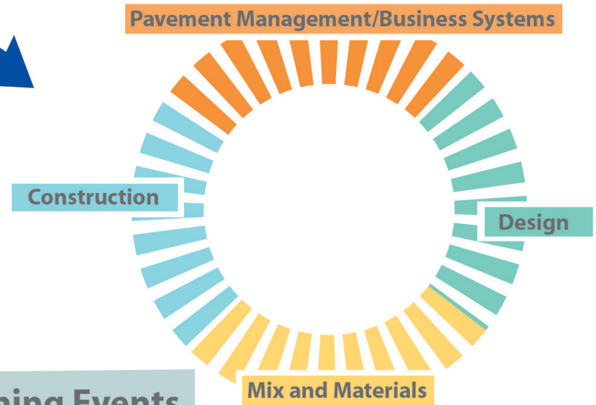
In a very real sense, the comprehensive research database developed as part of this project is the CP Road Map. Research problem statements, projects, budgets, timelines, and research results in the database must be regularly updated. The CP Road Map will succeed only as well as the database is managed and maintained.

CP Road Map Development Process

Research Database

A database of recent and in-progress concrete pavement-related research was developed.





5 Major Brainstorming Events

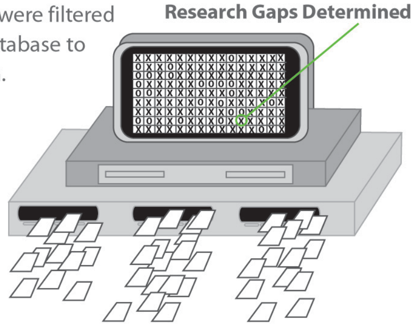
Several hundred stakeholders identified critical issues in design, mix and materials, construction, and pavement management/business systems.
In a reciprocal brainstorming process, participants at each event finetuned and added to previous discussions.

Research Objectives

The critical issues identified at the brainstorming events were developed into dozens of specific research objectives.

Gaps in Research

The research objectives were filtered through the research database to identify gaps in research.

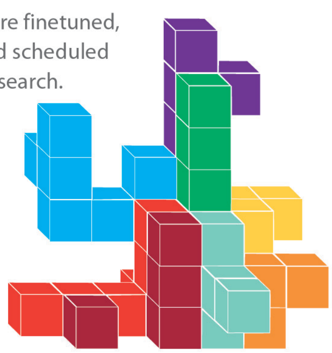


Problem Statements

Gaps in research became the basis for 250 problem statements.

Track Integration

Problem statements were finetuned, sorted and resorted, and scheduled into phased tracks of research.



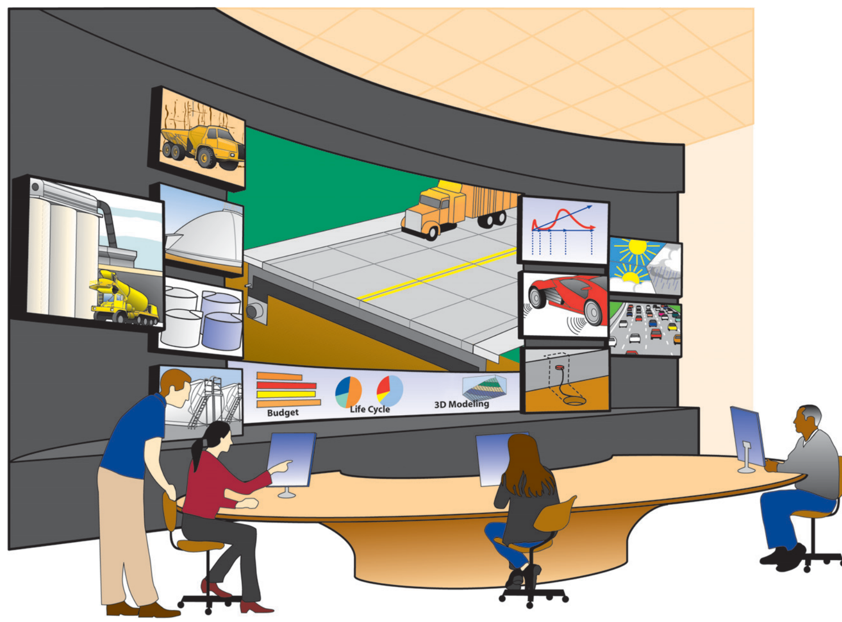
The 12 Tracks

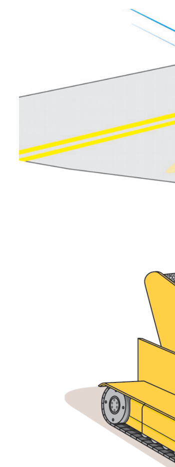
- Track 1 - Mix Design
- Track 2 - Design Guide
- Track 3 - Nondestructive Testing
- Track 4 - Surface Characteristics
- Track 5 - Equipment Advancements
- Track 6 - Innovative Joints
- Track 7 - Rehabilitation & Construction
- Track 8 - Long-Life Concrete
- Track 9 - Data Collection
- Track 10 - Pavement Performance
- Track 11 - Business & Economics
- Track 12 - Advanced Materials

A Quick Map of the CP Road Map

Following is a brief description of each research track:

1 **Performance-Based Concrete Pavement Mix Design System**: The final product of this track will be a practical yet innovative concrete mix design procedure with new equipment, consensus target values, common laboratory procedures, and full integration with both structural design and field quality control: a "lab of the future." This ambitious track also lays the groundwork for the concrete paving industry to assume more responsibility for mix designs as State highway agencies move from method specifications to more advanced acceptance tools. To do this, it is important that the concrete paving industry and owner-agencies refer to a single document for mix design state of the art.





2 **Performance-Based Design Guide for New and Rehabilitated Concrete Pavements**: Under this track, the concrete pavement research community will expand the mechanistic approach to pavement restoration and preservation strategies. This track builds on the comprehensive work done under NCHRP 1-37A (development of the mechanistic-empirical pavement design guide) and continues to develop the models from that key work. The work in this track needs to be closely integrated with track 1.

3 **High-Speed Nondestructive Testing and Intelligent Construction Systems**: This track will develop high-speed, nondestructive quality control systems to continuously monitor pavement properties during construction. As a result, on-the-fly adjustments can be made to ensure the highest quality finished product that meets given performance specifications. Many problem statements in this track relate to both tracks 1 and 2.

The "research track" concept

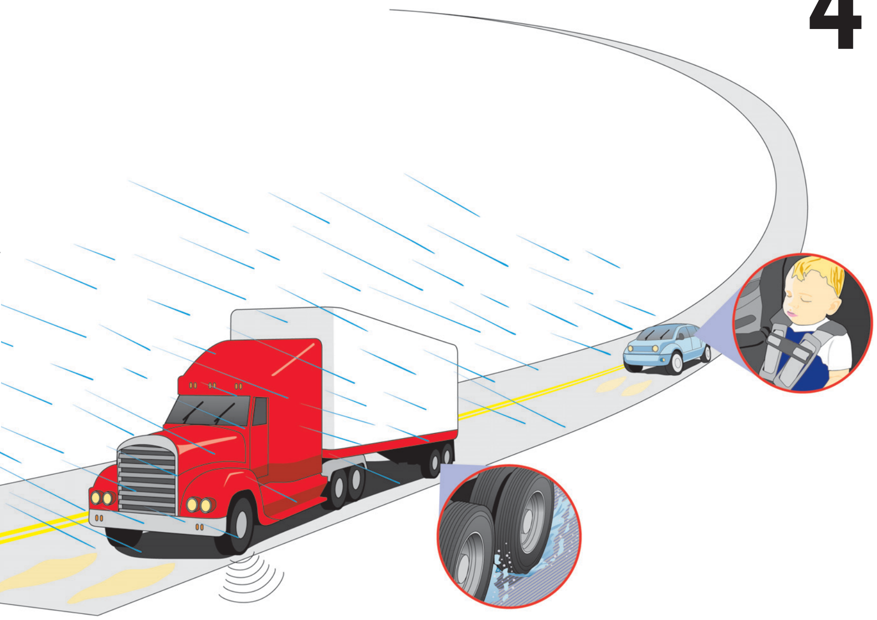
Each track is a full research program in itself, with its own budget, two to seven subtracks, and as many as 20 problem statements. Each of tracks 1 through 9 consists of a timed sequence of research leading to particular products that are essential to reaching the overall research goal. Tracks 10, 11, and 12 are not phased because timing is not as critical.

The products developed through the first four tracks may be especially critical to helping the industry achieve the full potential of concrete pavements:

- Performance-based mix design system.
- Performance-based design guide.
- High-speed nondestructive testing and intelligent construction systems.
- Performance-based systems for optimizing surface characteristics.

4

Optimized Surface Characteristics for Safe, Quiet, and Smooth Concrete Pavements: This track will result in a better understanding of concrete pavement surface characteristics. It will provide tools for engineers to help meet or exceed predetermined requirements for friction/safety, pavement-tire noise, smoothness, splash and spray, wheel path wear (hydroplaning), light reflection, rolling resistance, and durability (longevity). Each of these functional elements of a pavement is critical. The challenge is to improve one characteristic without compromising another one, especially when it comes to safety of the motoring public.



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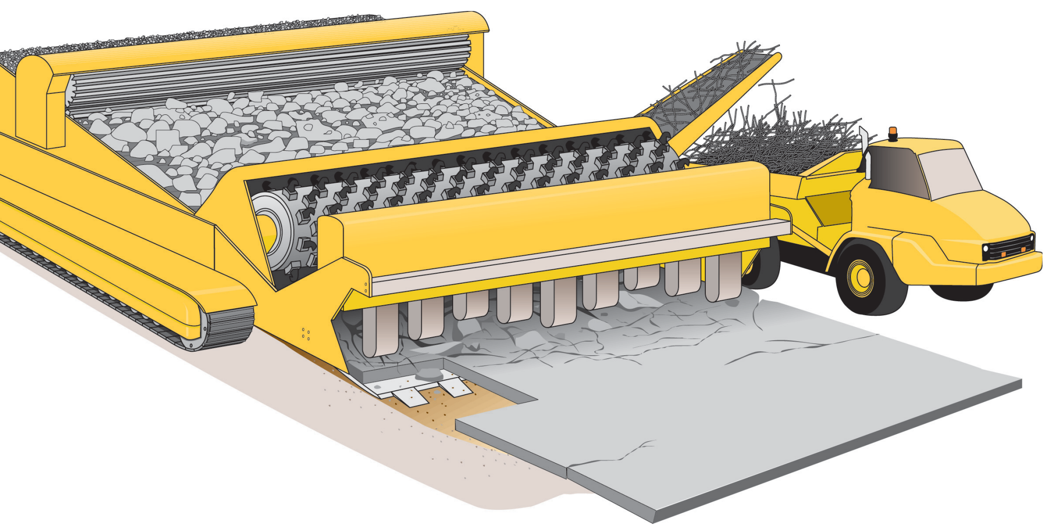
Equipment Automation and Advancements: This track will result in process improvements and equipment developments for high-speed, high-quality concrete paving equipment to meet the concrete paving industry's projected needs and the traveling public's expectations for highway performance in the future. Examples include the next generation of concrete batching and placement equipment; behind-the-paver equipment to improve curing, surface treatment, jointing, etc.; mechanized ways to place and control subdrains and other foundation elements; equipment to remove/replace the slab in one-pass construction; improved repair processes that decrease the time of operations and provide the workforce and traveling public with less exposure; and methods for evaluating new equipment on actual construction projects.



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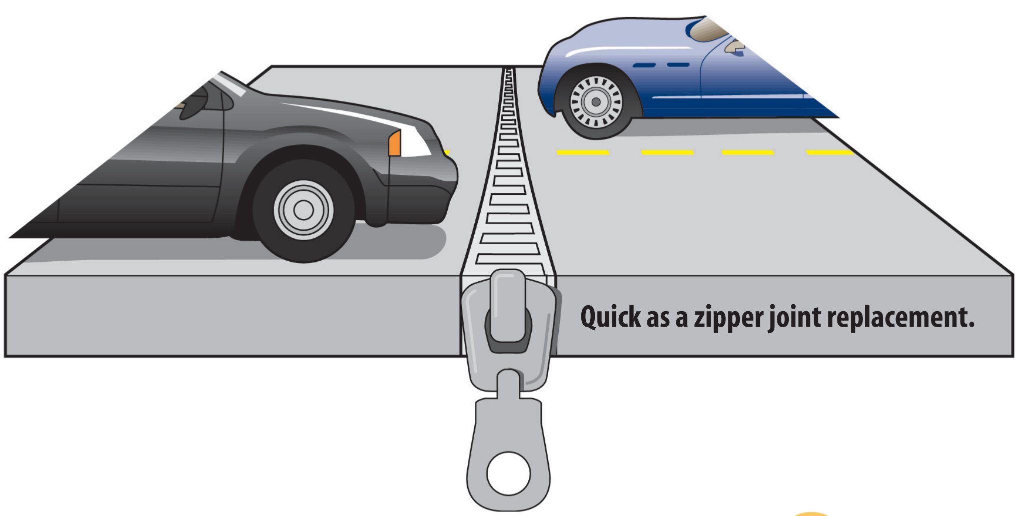
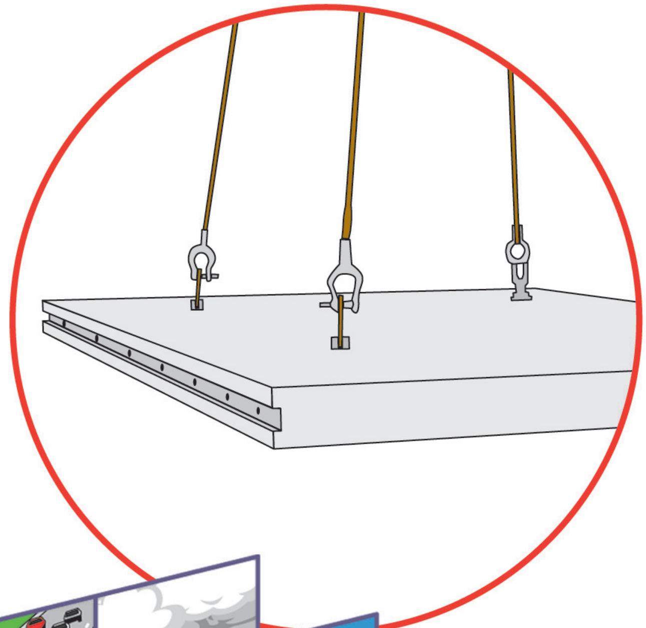
Innovative Concrete Pavement Joint Design, Materials, and Construction: Potential products for this track include a new joint design, high-speed computer analysis techniques for joint performance, a more accurate installation scheme, and faster rehabilitation strategies. The problem statements in this track address the basics—joint design, materials, construction, and maintenance activities. The track also specifies research that will help develop breakthrough technologies and very high-speed joint repair techniques. This is a cross-cutting track to ensure that all elements of this critical aspect are addressed. Much of the proposed research will develop important incremental improvements.

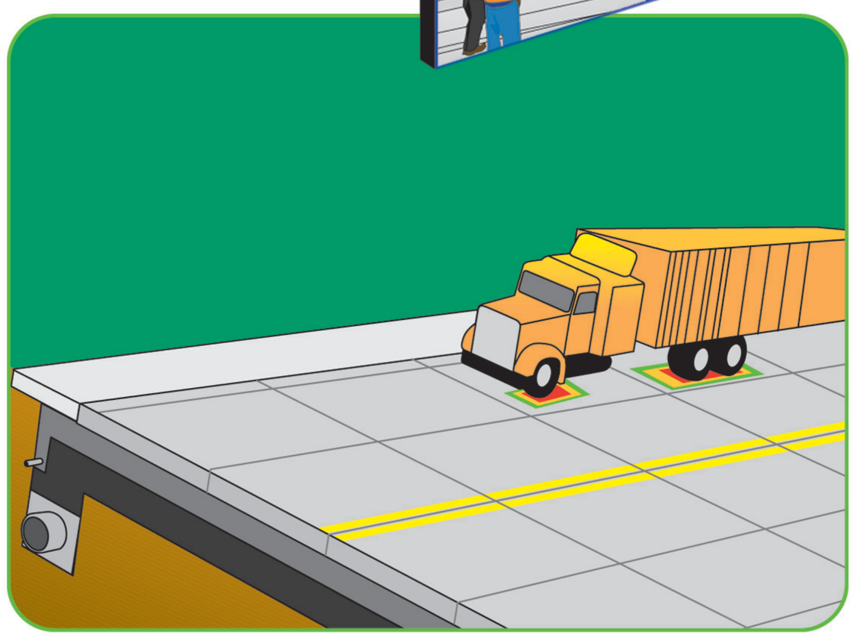


A Quick Map of the CP Road Map, Continued

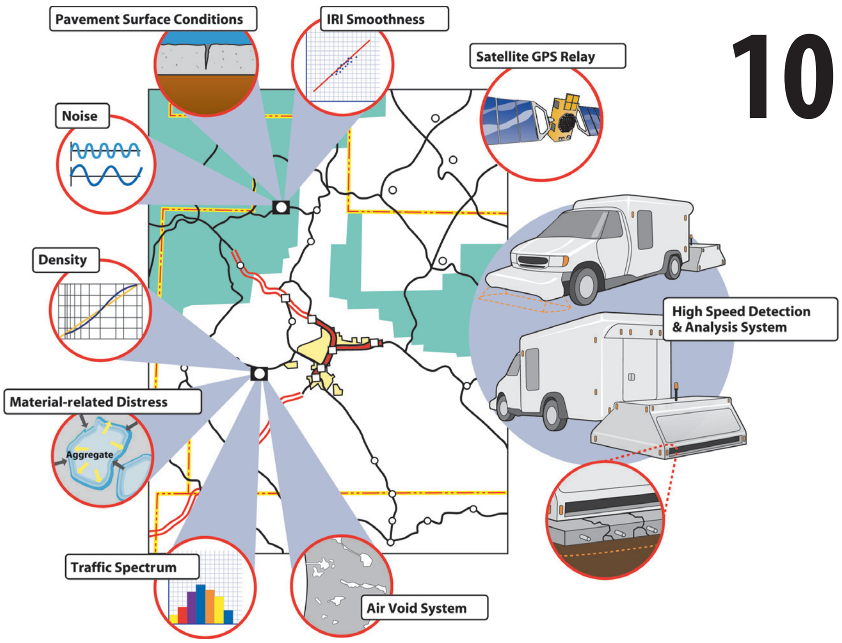


7 **High-Speed Concrete Pavement Rehabilitation and Construction:** Faster techniques and higher quality can and must be accomplished in the future. This track addresses a series of activities, from the planning and simulation of high-speed construction and rehabilitation, pre-cast and modular options for concrete pavements, and fast-track concrete pavement construction and rehabilitation, to the evaluation and technology transfer of high-speed construction and rehabilitation products and processes developed through research. Some high-speed construction issues are also investigated in tracks 1 and 3, and those efforts will be closely coordinated with this track.

8 **Long-Life Concrete Pavements**: The need for pavements that last longer between maintenance, restoration, or rehabilitation is integrated throughout the CP Road Map. However, this track draws attention to some specific research that may address pavement life approaching 60 years or more.



9 **Concrete Pavement Accelerated and Long-Term Data Collection**: This track provides the infrastructure for a future national program that will plan accelerated loading and long-term data needs, construct test sections, and collect and share data. The problem statements in this track will explore topics that will yield useful data and determine the amount of time needed to collect the data.



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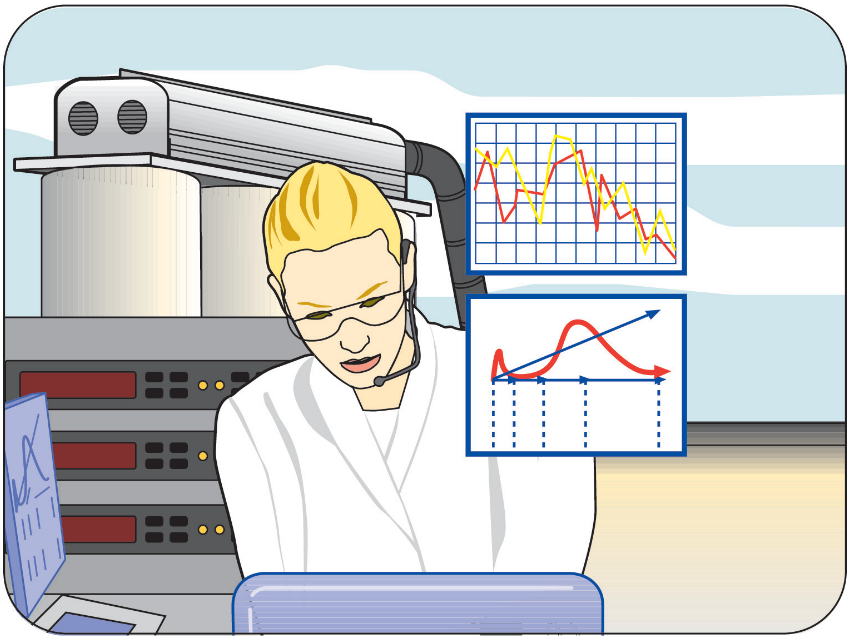
Concrete Pavement Performance: This track addresses key elements of pavement management and asset management systems. Such systems determine if and how pavements meet performance characteristics for highway agencies and users. Research in this track will determine and address the functional aspects of concrete pavement performance, particularly factors such as pavement-tire noise, friction, smoothness, and others. Research will also provide rapid concrete pavement performance feedback and consider ways to schedule surface characteristics and condition improvements. Developing feedback loops in highway agencies' pavement management systems will be crucial to monitor performance effectively and rapidly.

11

Concrete Pavement Business Systems and Economics: Roles and responsibilities are changing in the highway industry, affecting the way paving projects are designed, bid, built, and maintained. Contractors are being asked to assume more control of the operation and quality control inspections. By including warranty provisions in project contracts, owner-agencies are asking for additional assurance that pavements will be built and will perform as expected. Internationally, many countries have made dramatic changes in project-funding methods and in the roles of contractors and suppliers. This track captures some important research that should be considered as this process of transformation continues in this country. Problem statements cover contracting options, new technology transfer systems, public-private partnerships, economic models, etc.



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Advanced Concrete Pavement Materials: The problem statements in this track address the development of new materials and refine or reintroduce existing advanced materials to enhance performance, improve construction, and reduce waste. Many of the existing materials studied in this track have been used thus far on a small scale or in laboratory evaluations only. Many of them have not been used in the United States but show promise based on work done in other countries. This track will experiment with such materials on a larger scale and will develop standards and recommendations for their use. Moreover, this research will foster innovation in the development of additional, new, and innovative concrete pavement materials.

Reaching the Destination

The CP Road Map is accompanied by a Research Management Plan that outlines a progressive, cooperative approach to managing and conducting the research. Under this plan, organizations identify common interests, partner with each other in executing specific contracts, and, in the end, produce and share a product that is greater than the sum of the parts.

The Research Management Plan emphasizes scope control, phasing of research, reporting, systems integration, voluntary peer review, maintenance of the research database, program-wide technology transfer, and assistance to organizations that want to leverage their funds and human resources.

Philosophy for managing research

The Research Management Plan is based on several assumptions:

- First, the CP Road Map is a national research plan, not a plan solely for the FHWA but for State agencies and industry as well.
- Second, the CP Road Map is not restricted to any single funding source. Publicly financed highway research is decentralized and will probably remain so through the next highway bill.
- Which leads us to the third assumption. Even in a decentralized arena like research, it is possible—indeed, critical—for stakeholder groups to come together voluntarily. Federal, State, and industry research staff and engineers around the country are looking for more opportunities to pool their funds and other resources in win-win situations. The Midwest Concrete Consortium is an example of a successful cooperative approach to research.
- Fourth, the all-too-common disconnect between research results and implementation of those results must be fixed. Communication, technology transfer, and outreach activities must be elevated to the same level of importance as research itself.
- Finally, the CP Road Map is too comprehensive and too important for a part-time implementation effort. Managing the overall research program effectively and judiciously will require full-time, dedicated personnel with adequate resources.

Governing structure

In line with this general philosophy, the Research Management Plan outlines a four-tier system of participation and responsibility: an Executive Advisory Committee, an Administrative Support Group, research track team leaders, and sustaining organizations.

A tri-party **Executive Advisory Committee**, representing FHWA, State departments of transportation, and industry, will provide broad oversight of the CP Road Map. It will be a decision- and policymaking, facilitating group with many responsibilities:

- Assembling research track team leaders.
- Promoting partnering arrangements.
- Ensuring adequate integration of research across tracks.
- Developing and implementing a strategy to ensure that software products developed through various research tracks will be compatible.
- Identifying new research program areas.
- Overseeing the updating and maintenance of the research database.
- Developing a comprehensive technology transfer and training program for products of the CP Road Map.
- Developing a communications effort to keep the CP Road Map and its products in front of stakeholders and the public.
- Conducting self-evaluation studies.
- Keeping the momentum focused on outcomes, not just output.

An **Administrative Support Group** will provide professional management services for the Executive Advisory Committee and, to a lesser degree, the research track team leaders. It will be the "doing" body for all coordinating and support activities, like maintaining the research database.

Research track team leaders will coordinate and oversee all activities within a specific research track:

- Validating and updating the track.
- Developing discrete research projects, with scopes of work, timelines, and budgets.
- Identifying organizations wanting to conduct or partner in the research.
- Establishing and overseeing subordinate technical expert working groups to guide complex work.
- Ensuring proper integration of work within the track and across track lines.
- Developing status reports.

Sustaining organizations—agencies, consultants, universities, professional associations, and other organizations that have specialized interests and skills and are interested in pooling dedicated funds—will assume responsibility for conduct of research through cooperation, partnering, and funding agreements.

Sustaining organizations conducting research under the CP Road Map may retain full fiscal and technical control of the work under their jurisdiction. The key to successful conduct of the research, however, is cooperation, and the Research Management Plan facilitates and supports cooperative efforts.

Certainly, some people and organizations will assume multiple roles.

How Can You Participate?

Beginning a long-term research program is a little like turning an oceanliner around; it's a long, slow sweep. In this case, we have a strong rudder—the CP Road Map—turned in the right direction. It's time to fire the engines, full speed ahead.

As a stakeholder in the concrete pavement community, you're invited to get on board before the ship leaves port:

- To receive a printed copy of the CP Road Map, with complete problem statements and tracks (available spring 2005), contact Peter Kopac, Federal Highway Administration, 202-493-3151, peter.kopac@fhwa.dot.gov. (An electronic version will be available on the Center for Portland Cement Concrete Pavement Technology (PCC Center) website after February 14, 2005; see www.pcccenter.iastate.edu/.)
- If you are interested in leading a specific research track or in partnering with other organizations to lead a track, contact the PCC Center, Iowa State University, 515-294-8103, pcconc@iastate.edu.

The research products may be great, but what if nobody uses them?

Studies show that even with the advent of the internet, email, teleconferencing, and other similar advancements, it still takes more than a decade for an advancement to move into practice.

In the CP Road Map, one subtrack in every phased track is devoted to developing innovative technology transfer and training tools and methods to ensure that innovative products of research are quickly and efficiently moved into practice. In addition, one of the most important responsibilities of the Executive Advisory Committee will be to develop a new technology transfer and information system.

Research Management Plan

Executive Advisory Committee

(Composed of Federal, States, and Industry)

Potential Sustaining Organizations

-FHWA	-NCHRP	-AASHTO
-NRMCA	-ACPA	-NSSGA
-TRB	-PCA	-Individual DOTs
-MC^2	-Others	

- CP Road Map updates; integration of research tracks
- Research Database Management
- Integration of New Software Products
- Communications & Technology Transfer
- Partnering & Fund Management
- Innovative Research (CP - IDEA)

Administrative Support Group

(Primarily provides support for Executive Steering Committee)

(also provides support for research track team leaders)

- Provide lists of potential track leaders
- Suggest and facilitate partnering arrangements
- Help integrate research across tracks
- Update and maintain the research database
- Obtain information from State and Federal agencies on current research
- Develop recommendations for improving, adjusting, or adding new research
- Solicit new and innovative ideas and concepts
- Organize continuous expert review and advice on conduct of research
- Recommend strategies to ensure software compatibility
- Address intellectual property rights issues
- Identify and recommend technology transfer activities
- Identify and facilitate the development of specific, track-related training efforts
- Develop and implement a communications effort

Research Track Team Leaders

(Oversee work within each track: schedules, budgets, integration, plan updates)

Track 1 Leaders
Mix Design

Track 2 Leaders
Design Guide

Track 3 Leaders
Nondestructive Testing

Track 4 Leaders
Surface Charactaristics

Track 5 Leaders
Equipment Advancements

Track 6 Leaders
Innovative Joints

Track 7 Leaders
Rehabilitation & Construction

Track 8 Leaders
Long-Life

Track 9 Leaders
Data Collection

Track 10 Leaders
Pavement Performance

Executive Advisory Committee will be the track leader for Track 11.

Track 11 Leaders
Business Systems & Economics

Track 12 Leaders
Advanced Materials

The CP Road Map is a 7- to 10-year plan for concrete pavement research consisting of the following tracks and subtracks:

1 Performance-Based Concrete Pavement Mix Design System — $30–68M*

Subtracks
1. PCC Mix Design System Development and Integration
2. PCC Mix Design Laboratory Testing and Equipment
3. PCC Mix Design Modeling
4. PCC Mix Design Evaluation and Implementation

2 Performance-Based Design Guide for New and Rehabilitated Concrete Pavements — $41–60M

Subtracks
1. Design Guide Structural Models
2. Design Guide Inputs, Performance Models, and Reliability
3. Special Design and Rehabilitation Issues
4. Improved Mechanistic Design Procedures
5. Design Guide Implementation

3 High-Speed Nondestructive Testing and Intelligent Construction Systems — $20–41M

Subtracks
1. Field Control
2. Nondestructive Testing Methods
3. Nondestructive Testing and Intelligent Control System Evaluation and Implementation

4 Optimized Surface Characteristics for Safe, Quiet, and Smooth Concrete Pavements — $25–54M

Subtracks
1. Concrete Pavement Texture and Friction
2. Concrete Pavement Smoothness
3. Tire-Pavement Noise
4. Other Concrete Pavement Surface Characteristics
5. Integration of Concrete Pavement Surface Characteristics
6. Evaluation of Products for Concrete Pavement Surface Characteristics
7. Concrete Pavement Surface Characteristics Implementation

5 Concrete Pavement Equipment Automation and Advancements — $26–56M

Subtracks
1. Concrete Batching and Mixing Equipment
2. Concrete Placement Equipment
3. Concrete Pavement Curing, Texturing, and Jointing Equipment
4. Concrete Pavement Foundation Equipment
5. Concrete Pavement Reconstruction Equipment
6. Concrete Pavement Restoration Equipment
7. Advanced Equipment Evaluation and Implementation

6 Innovative Concrete Pavement Joint Design, Materials, and Construction — $10–15M

Subtracks
1. Joint Design Innovations
2. Joint Materials, Construction, Evaluation, and Rehabilitation Innovations
3. Innovative Joints Implementation

7 High-Speed Concrete Pavement Rehabilitation and Construction — $10–20M

Subtracks
1. Rehabilitation and Construction Planning and Simulation
2. Precast and Modular Concrete Pavements
3. Fast-Track Concrete Pavements
4. Rehabilitation and Construction Evaluation and Implementation

8 Long-Life Concrete Pavements — $11–17M

Subtracks
1. Pavement Strategy for Long-Life Concrete Pavements
2. Construction and Materials for Long-Life Concrete Pavements and Overlays
3. Long-Life Concrete Pavement Implementation

9 Concrete Pavement Accelerated and Long-Term Data Collection — $10–16M

Subtracks
1. Planning and Design of Accelerated Loading and Long-Term Data Collection
2. Materials, Construction, Monitoring, and Reporting on Testing
3. Accelerated Loading and Long-Term Data Collection Implementation

10 Concrete Pavement Performance — $3–4M

Subtracks
1. Technologies for Determining Concrete Pavement Performance
2. Guidelines and Protocols for Concrete Pavement Performance

11 Concrete Pavement Business Systems and Economics — $21–31M

Subtracks
1. Concrete Pavement Research and Technology Management and Implementation
2. Concrete Pavement Economics and Life-Cycle Costs
3. Contracting and Incentives for Concrete Pavement Work
4. Technology Transfer and Publications for Concrete Pavement Best Practices
5. Concrete Pavement Decisions with Environmental Impact

12 Advanced Concrete Pavement Materials — $11–23M

Subtracks
1. Performance-Enhancing Concrete Pavement Materials
2. Construction-Enhancing Concrete Pavement Materials
3. Environment-Enhancing Concrete Pavement Materials

$218–$405M Total

***All numbers are rounded**