Long-Term Plan for Concrete Pavement Research and Technology—The Concrete Pavement Road Map (Second Generation): Volume I, Background and Summary

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U.S. Department of Transportation
Federal Highway Administration

Research, Development, and Technology
Turner-Fairbank Highway Research Center
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Original Track/Subtrack Structure

Track 1. Performance-Based Concrete Pavement Mix Design System (MD)
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Subtrack MD 2. PCC Mix Design Laboratory Testing and Equipment
Subtrack MD 3. PCC Mix Design Modeling
Subtrack MD 4. PCC Mix Design Evaluation and Implementation

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Subtrack LL 2. Construction and Materials for Long-Life Concrete Pavements and Overlays
Subtrack LL 3. Long-Life Concrete Pavement Implementation

New Track/Subtrack Structure

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Subtrack 1-3. Innovative Materials
Subtrack 1-4. Materials Proportioning
Subtrack 1-5. Mixture Evaluation
Subtrack 1-6. Completed Pavement Materials Evaluation

Track 2. Performance-Based Design Guide for New and Rehabilitated Concrete Pavements
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Subtrack 2-3. Special Design and Rehabilitation Issues
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Subtrack 2-5. Design Guide Implementation

Track 3. Intelligent Construction Systems and Quality Assurance for Concrete Pavements
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Track 8. Concrete Pavement Construction, Reconstruction, and Overlays
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Original Track/Subtrack Structure

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Track 11. Concrete Pavement Business Systems and Economics (BE)
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Subtrack BE 4. Technology Transfer and Publications for Concrete Pavement Best Practices
Subtrack BE 5. Concrete Pavement Decisions with Environmental Impact

Track 12. Advanced Concrete Pavement Materials (AM)
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Subtrack AM 2. Construction-Enhancing Concrete Pavement Materials
Subtrack AM 3. Environment-Enhancing Concrete Pavement Materials

Track 13. Concrete Pavement Sustainability

New Track/Subtrack Structure

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Subtrack 9-2. Pavement Strategy for Long-Life Concrete Pavements
Subtrack 9-3. Construction and Materials for Long-Life Concrete Pavements and Overlays
Subtrack 9-4. Planning and Design of Accelerated Loading and Long-Term Data Collection
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Subtrack 9-6. Long-Life Concrete Pavement Performance Implementation

Track 10. Concrete Pavement Foundations and Drainage
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Subtrack 12-7. Identification and Quantification of Additional Environmental and Social Considerations for Sustainable Concrete Pavements
Subtrack 12-8. Concrete Pavement Decisions with Positive Environmental Impact
Subtrack 12-9. Sustainable Concrete Pavement Technology Transfer and Implementation

Opportunity in Concrete Pavement Technology Deployment

2012 National CP Tech Center Technical Training for CP Road Map Pool Funded States

Training Opportunities

The curriculum that is available for 2012 is for a one-day training workshop or seminar on the following choices:

1. IMCP Manual, Integrated Materials and Construction Practices for Concrete Pavement: You may select specific subjects within the manual for emphasis if that is of interest.
2. Concrete Pavement Preservation Training
3. Design and Construction of Concrete Overlays
4. Roller Compacted Concrete
5. Concrete Pavement Surface Characteristics
6. Concrete Paving Mixture (COMPASS Software explanation)
7. Quality in Concrete Paving Process (Quality Assurance Training)
8. Early Age Cracking
9. Cement Based Integrated Pavement Solutions

Opportunity in Concrete Pavement Technology Deployment

Location	Workshop Topic	Workshop Date
Richmond, Virginia	Surface Characteristics	February 8, 2012
Grand Rapids, Michigan	IMCP Subjects	February 14-15, 2012
New York, New York	IMCP/Preservation	March 13, 2012
Jackson, Mississippi	Preservation	March 22, 2012
King of Prussia, Pennsylvania	IMCP/Overlays	April 12, 2012
Iowa	TBD	TBD

CS Track 13:

Concrete Pavement Sustainability

- Goals
- Activities to date
- Publications
- Research projects
- People involved

Goals

The Concrete Pavement Sustainability track is the most recent addition to the CP Road Map. The objective of this track is to identify and complete research and implementation that improves concrete pavement sustainability through the pavement's life cycle (design, materials selection, construction, operation, maintenance, restoration, rehabilitation, and recycling).

Activities to Date

- The team is developing a "best practices" training manual and implementation package for concrete pavement sustainability that will provide detailed technical information to engineers, material suppliers, and contractors.
- Federal and State partners will conduct demonstration projects that feature sustainable solutions and effectively communicate the successes of these projects.

Publications

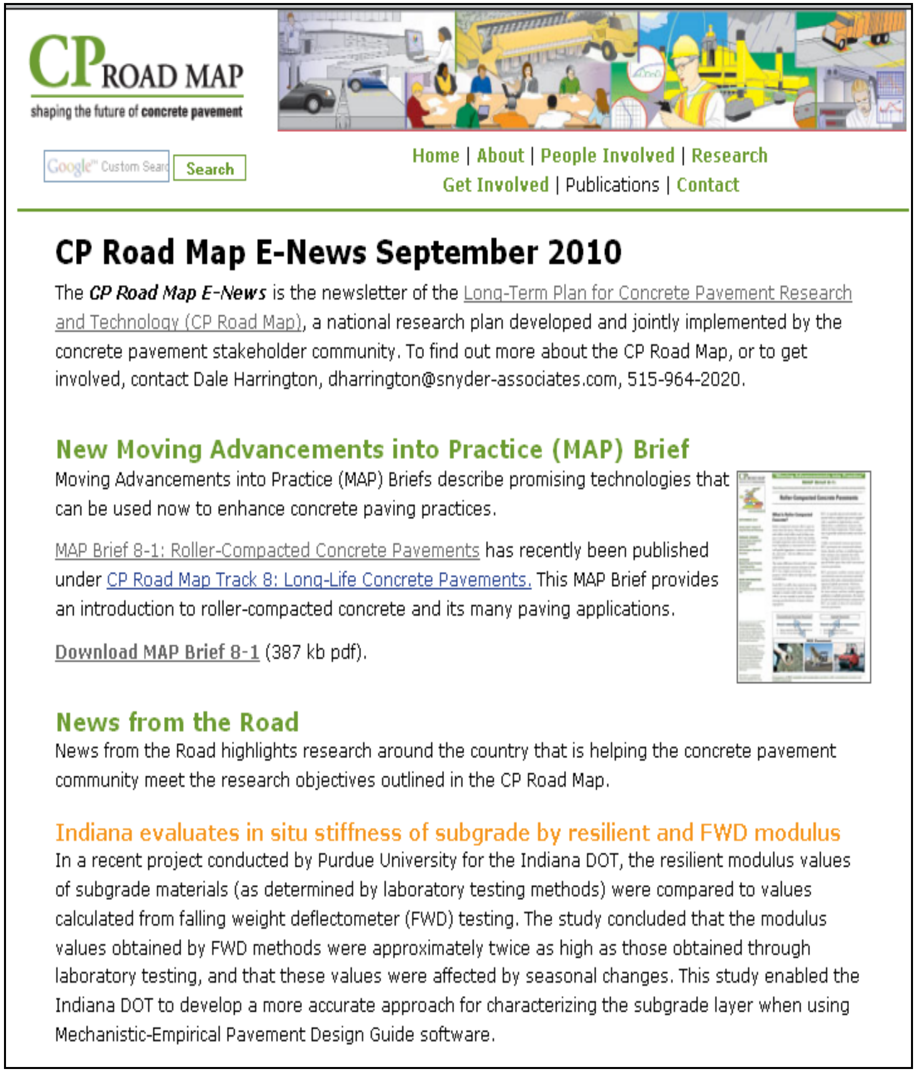
- Building Sustainable Pavements with Concrete: Briefing Document
- Framing report for Track 13: Concrete Pavement Sustainability
- Minutes from the first meeting of the Track 13: Concrete Pavement Sustainability Leadership Team

Research projects

- Recycled Materials Resource Center pooled fund
- Recycled Unbound Pavement Materials (MnROAD Study)
- Marginal and Innovative Materials in Concrete Paving (Local / P200 Fines) GAP 2.5

CP Road Map MAP Briefs

	TOPIC	TRACK ASSIGNMENT
Completed	COMPASS Mix Design and Analysis Tool	Track 1 – Mix Design
Completed	Durability PCC Pavements Subject to Ch Deicers	Track 1 – Mix Design
Completed	Two-Lift Concrete Paving	Tracks 8 – Long Life Pavements; 5 – Equipment Adv
Completed	Sustainability	Track 13 – Sustainability
Completed	Stringless Paving	Track 5 – Equipment Auto
Completed	Recycling Concrete Pavement	Tracks 7 – Rehab & Const; 8 – Long Life; 13 - Sustainability
Completed	Roller Compacted Concrete	Tracks 8 – Long Life; 5 – Equipment Adv
Completed	Pervious Concrete Pavements	Tracks 1 – Mix Design; 13 – Sustainability; 12 – Adv Matls
Completed	Diamond Grinding	Track 4 – Surface Characteristics
Completed	Effective Use of Nonwoven Geotextiles as Interlayers in Concrete Pavement	Track 7 – Rehab & Const
Jan 2011	Smart Pavements (Smart Cure)	Track 10 – Pvmt Performance
Feb 2011	Intelligent Compaction	Tracks 2 – Design; 3 – Non Destructive; 5 – Equipment Auto
Mar 2011	Effective Use of Fly Ash & Slag Cements	Track 7 – Rehab & Const
Apr 2011	Joint Deterioration	Tracks 6 – Joint Innovation; 8 – Long Life
May 2011	Pavement Preservation – New Partial Depth Patching	Track 7 – Rehab & Const
Jun 2011	Identifying and Avoiding Incompatible Combination of Concrete Materials	Track 1 – Mix Design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CP Road Map E-News September 2010

The ***CP Road Map E-News*** is the newsletter of the Long-Term Plan for Concrete Pavement Research and Technology (CP Road Map), a national research plan developed and jointly implemented by the concrete pavement stakeholder community. To find out more about the CP Road Map, or to get involved, contact Dale Harrington, dharrington@snyder-associates.com, 515-964-2020.

New Moving Advancements into Practice (MAP) Brief

Moving Advancements into Practice (MAP) Briefs describe promising technologies that can be used now to enhance concrete paving practices.

MAP Brief 8-1: Roller-Compacted Concrete Pavements has recently been published under CP Road Map Track 8: Long-Life Concrete Pavements. This MAP Brief provides an introduction to roller-compacted concrete and its many paving applications.

Download MAP Brief 8-1 (387 kb pdf).

News from the Road

News from the Road highlights research around the country that is helping the concrete pavement community meet the research objectives outlined in the CP Road Map.

Indiana evaluates in situ stiffness of subgrade by resilient and FWD modulus

In a recent project conducted by Purdue University for the Indiana DOT, the resilient modulus values of subgrade materials (as determined by laboratory testing methods) were compared to values calculated from falling weight deflectometer (FWD) testing. The study concluded that the modulus values obtained by FWD methods were approximately twice as high as those obtained through laboratory testing, and that these values were affected by seasonal changes. This study enabled the Indiana DOT to develop a more accurate approach for characterizing the subgrade layer when using Mechanistic-Empirical Pavement Design Guide software.

CP Road Map E-News

Accomplishments

- 8 E-News issues published
- Each with links to a minimum of four research efforts of interest
- 6 State Highlights
  - Indiana
  - Michigan
  - Wisconsin
  - Minnesota
  - Pennsylvania

CP Road Map E-News

The following topics were covered:

- April 2010
  - Virginia Transportation Research Council studies benefits of nano materials
  - Texas Transportation Institute evaluates effectiveness of curing techniques
  - Minnesota DOT examines effects of pavement drainage on joint behavior
- May 2010
  - Texas Transportation Institute studies design of concrete pavement transitions
  - Washington DOT examines dowel bar retrofit to extend pavement life
  - ACI releases report on pervious concrete
  - Minnesota DOT launches web page on concrete overlays
  - Nonwoven geotextile interlayers gaining popularity in the U.S.
  - Update from Indiana

CP Road Map E-News

- July-August 2011
  - Innovative Pavement Research Foundation investigates optimum use of fly ash in airfield concrete pavements
  - Minnesota researchers evaluate cold weather performance of pervious pavements
  - Pennsylvania DOT examines premature deterioration of jointed concrete pavement sections
  - New Jersey researcher utilizes nanotechnology to strengthen concrete
  - Update from California

CP Road Map E-News

- September-October 2011
  - Pennsylvania evaluates statewide design inputs for the Mechanistic-Empirical Pavement Design Guide
  - Seal/No Seal Group publishes tech brief on backer rod absorption
  - Virginia DOT develops end-result specification for hydraulic cement
  - National CP Tech Center publishes tech summary on design of concrete overlays
  - Update from Kansas

CP Road Map E-News

- November-December 2011
  - Colorado DOT evaluates tie bar system for longitudinal joints
  - FHWA publishes tech brief on the impact of coefficient of thermal expansion on concrete pavement design
  - Washington State DOT investigates studded tire wear on concrete pavements
  - National CP Tech Center publishes technology deployment plan for the use of recycled concrete aggregate
  - Update from Illinois

CP Road Map E-News

- January-February 2012
  - Maryland DOT investigates use of concrete maturity method
  - National CP Tech Center publishes comprehensive study on pervious concrete
  - Wisconsin DOT explores lowering cementitious materials content of concrete pavements
  - Michigan researchers evaluate use of recycled concrete for new construction
  - Update from Oklahoma

CP Road Map MAP Briefs

Moving Advancements into Practice

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"Moving Advancements into Practice"

MAP Brief

Describing promising technologies that can be used now to enhance concrete paving practices

JULY–AUGUST 2011

ROAD MAP TRACK 7
Concrete Pavement Maintenance and Preservation

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This MAP Brief is available at: http://www.cproadmap.org/publications/ MAPbriefJul-Aug11.pdf

Full-Depth Reclamation of Asphalt Pavements with Cement

Introduction

Engineers and public works officials are discovering a cost-effective process for recycling failed asphalt pavements. The process, called full-depth reclamation with cement, rebuilds worn-out roadway by recycling the existing asphalt pavements. The old asphalt and base materials are pulverized, mixed with cement and water, and compacted to produce a strong, durable base for either an asphalt or concrete surface.

Full-depth reclamation uses the old asphalt and base material for the new road. There's no need to haul in aggregate or haul out old material for disposal. Truck traffic is reduced, and there is little or no waste. Full-depth reclamation uses the materials from the deteriorated asphalt pavement and, with the addition of cement, creates a new stabilized base. A surface consisting of a thin bituminous chip seal, asphalt, or concrete completes the road.

The recycled base will be stronger, more uniform, and more moisture-resistant than the original base, resulting in a long-lasting, low-maintenance pavement. Recycling costs are typically 25% to 50% less than the costs of removing and replacing the old pavement.

Candidates for full-depth reclamation

Full-depth reclamation is appropriate under the following conditions:

- The pavement is damaged and cannot be rehabilitated with simple resurfacing methods.
- The existing pavement distress indicates that a primary problem likely exists below the surface in the base and/or subgrade.
- The existing pavement distress would otherwise require full-depth patching over more than 15%–20% of the surface area.
- The pavement structure is inadequate for the current or future traffic.

The reasons for pavement failure can be determined by observing the types of distress that are visible. For example, alligator cracking, numerous potholes, excessive patching, or soil stains on the pavement surface are all signs of base or subgrade problems in the pavement structure (figure 1).

Figure 1. Deteriorated asphalt pavements that are candidates for full-depth reclamation with cement

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"Moving Advancements into Practice"

MAP Brief

Describing promising technologies that can be used now to enhance concrete paving practices

SEPT-OCT 2011

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Introducing -- The CP Road Map, 2nd Edition

Introduction

The CP Road Map is a comprehensive and strategic plan for concrete pavement research that guides the investment of research dollars. It is a living plan with broad stakeholder involvement. Since 2005, it has tracked research and facilitated the deployment of technologies that have been helping the concrete pavement community meet paving challenges. In short, the CP Road Map is guiding the industry toward a new generation of concrete pavements.

The development of the CP Road Map began in 2001 through an agreement between the Federal Highway Administration and the National Concrete Pavement Technology Center at Iowa State University. The team developed a database of existing research and gathered input from the highway community. They identified gaps in research that became the basis for problem statements, which are organized into a cohesive, strategic research plan.

CP Road Map Update

Today, the CP Road Map is funded through a transportation pooled fund that includes FHWA and several State DOTs. As the CP Road Map has evolved, areas for improvement have been identified. Consequently, the CP Road Map has been updated to reflect progress made to date on various tracks. The track structure has also been revised and updated to better reflect current practices and to emphasize important areas of research. The updated CP Road Map incorporates items originally referenced only in database tables into the formal track structure.

In updating the CP Road Map, one objective was to introduce a variety of new subtracks and problem statements. It was also critical to maintain cohesiveness with problem statements that are cross-referenced between multiple tracks and to reflect current industry practices and research completed to date by removing irrelevant or outdated problem statements. In addition, the "phasing" structure of the original CP Road Map was omitted in order to remove the impression that certain research can occur only after other research has been completed.

The table on the following two pages illustrates key differences between the original and updated CP Road Map tracks and problem statements.

Other than updates to select problem statements, no major changes were made to Tracks 2, 4, 5, and 6. For the remaining tracks, the revisions are outlined below.

Track 1 - Materials and Mixes for Concrete Pavements

- Now covers both concrete materials and mix designs, with an emphasis still placed on performance-based mixture designs.
- Incorporates much of the original Track 12 - Advanced Concrete Pavement Materials.

Track 3 - Intelligent Construction Systems and Quality Assurance for Concrete Pavements

- Track and subtracks have been renamed to reflect current industry practice.
- Emphasis has been placed on quality assurance (QA), an umbrella term that has traditionally been associated with QA/QC.

Track 7 - Concrete Pavement Maintenance and Preservation

- New focus is on maintenance and preservation as these are key areas of research given the current economic climate.
- Incorporates items from Appendix A, Table B (Concrete Pavement Maintenance and Rehabilitation) of the original CP Road Map.

CP Road Map MAP Briefs

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NOVEMBER 2011

ROAD MAP TRACK 8
Concrete Pavement Construction, Reconstruction, and Overlays

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This MAP Brief is available at: http://www.cproadmap.org/ publications/ MAPbriefNov-Dec11.pdf

"Moving Advancements into Practice"

MAP Brief November–December 2011

Describing promising technologies that can be used now to enhance concrete paving practices

Precast Concrete Pavements

Introduction

Since 2001, nearly 30 lane-miles of precast pavement have been constructed in 12 States and two Canadian provinces. Nearly triple this amount is now in service overseas (based largely on U.S. practice). While many projects have been constructed as demonstrations of the technology, several highway agencies recognize the advantages of precast pavement and are beginning to adopt it as standard practice for certain types of projects.

Precast pavement is a long-life solution primarily used for rapid reconstruction and rehabilitation of existing pavements with short construction windows. However, it has also been used for construction of new pavements where cast-in-place concrete is not a viable option due to lack of availability of ready-mix concrete batch plants and slipform paving equipment. Precast panels are fabricated and cured in a controlled environment (figure 1), ensuring a durable, long-lasting product. On-site cure time is not required. The top face of the panels serves as the riding surface for the finished pavement, which allows opening to traffic immediately after the panels are installed.

Primary Methods

Two precast pavement methods are predominantly used in the United States: precast prestressed concrete pavement (PPCP) and jointed precast pavement (JPP) systems.

Precast Prestressed Concrete Pavement

PPCP utilizes prestressing to put the pavement slab in compression in order to reduce tensile stresses and the potential for cracking. Prestressing can be incorporated through pretensioning at the fabrication plant and through post-tensioning on site.

Prestress results in thinner precast panels when compared to a conventional cast-in-place pavement design, and longer spacing (100–250 ft +) between working joints in the pavement slab. Keyways are formed into the edges of the panels to help align the panels as they are installed (figure 2).

Load transfer between individual precast panels is provided through compression of the joints between panels from post-

Figure 1. Precast concrete pavement panels are produced and cured in a controlled environment (steam curing [bottom] is not required but is an option for some precasters).

Figure 2. PPCP panels utilize keyways for alignment during installation.

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ROAD MAP TRACK 7
Concrete Pavement Maintenance and Preservation

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This MAP Brief is available at: http://www.cproadmap.org/ publications/ MAPbriefJan-Feb12.pdf

"Moving Advancements into Practice"

MAP Brief January–February 2012

Describing promising technologies that can be used now to enhance concrete paving practices

Full-Depth Repairs for Concrete Pavements

Introduction

A full-depth repair (FDR) is defined as a cast-in-place concrete repair that extends through the full thickness of the existing pavement.

FDRs are an effective method to extend the service life of a pavement when used in the correct repair applications. Typically, FDRs are appropriate for pavements with distresses that are material related or distresses that extend beyond the upper half of the pavement and affect ride or safety (figure 1). Distresses that are located in the upper half of the slab can be addressed with partial-depth repairs.

Specific types of distress include transverse cracking, corner breaks, longitudinal cracking, deteriorated joints, blowups, and punchouts. FDRs may also be used in conjunction with bonded or unbonded concrete overlays.

Project Selection

Concrete pavements with deterioration primarily surrounding joints or cracks are good candidates for FDRs, particularly if the deterioration is in a concentrated area and not throughout the length of the pavement. If the FDR repair area is greater than five to ten percent of the total pavement area, the effectiveness of a FDR is reduced. FDR can be used in jointed concrete, jointed reinforced concrete, and continuously reinforced concrete pavements.

Figure 1. Deteriorated pavement that is a good candidate for FDR

In pavements with severe material-related problems, such as high levels of D-cracking, or reactive aggregate, such as alkali-silica reaction, FDR will only provide temporary relief and the distresses will likely reoccur.

Materials and Design Considerations

Extensive subsurface deterioration is often prevalent near punchouts or at faulting along the longitudinal joint. Studies and investigations are recommended to determine the extent of the deterioration and to understand the magnitude of the project.

Material and design considerations vary between jointed concrete pavement (JCP)and continuously reinforced concrete pavement (CRCP).

Jointed Concrete Pavements

Accurate sizing of the repair is essential to a successful FDR. Sometimes the deterioration at the bottom of the slab may extend as much as 3 ft outside the visual deterioration on the surface when the pavement has a material-related distress (figure 2). The repair dimensions can be identified through coring and deflection tests.

For pavements with dowels, 6 ft is the recommended minimum repair length to reduce pumping or break-up of the slab. Full width replacements are preferred because they result in a more stable patch due to the well-defined boundaries.

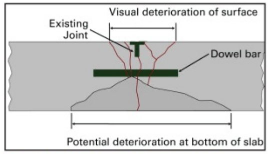

Figure 2. Deterioration beneath joint