CP ROAD MAP
shaping the future of concrete pavement

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ROAD MAP TRACK 8

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The Long-Term Plan for Concrete Pavement Research and Technology (CP Road Map) is a national research plan developed and jointly implemented by the concrete pavement stakeholder community. Publications and other support services are provided by the Operations Support Group and funded by TPF-5(185).

Moving Advancements into Practice (MAP) Briefs describe innovative research and promising technologies that can be used now to enhance concrete paving practices. The May–June 2012 MAP Brief provides information relevant to Track 8 of the CP Road Map: Concrete Pavement Construction, Reconstruction, and Overlays.

This MAP Brief is available at www.cproadmap.org/publications/MAPbriefMay-Jun2012.pdf.

“Moving Advancements into Practice”

MAP Brief May–June 2012

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

Multi-Year Concrete Overlays Program: What We have Accomplished and Learned

The states of Colorado, Iowa, Kansas, Michigan, Minnesota, Missouri, and Oklahoma have long been leaders in the application of concrete overlays as versatile, cost-effective solutions for a variety of pavement repair and rehabilitation needs. In the mid-2000s, the National Concrete Pavement Technology Center (CP Tech Center) at Iowa State University recognized an opportunity to help extend the implementation of concrete overlays to other states. With the cooperation and technical support of the lead states listed above, the Federal Highway Administration (FHWA), and the American Concrete Pavement Association, the CP Tech Center initiated a four-pronged, multi-year program of research and outreach activities. The program has involved numerous projects funded through a cooperative agreement with the FHWA.

This MAP Brief summarizes the program’s activities and, most important, highlights critical lessons learned that are helping agencies across the country design and construct successful concrete overlay solutions.

Accomplishments

The multi-year concrete overlays program involved the following activities:

1. Conducted a field applications program to help states design, plan, construct, and evaluate a variety of concrete overlay projects.
2. Identified specific challenges and improvement opportunities and conducted research to address them.
3. Developed a series of publications, incorporating best research results and practices to date, to guide design and construction of concrete overlays to meet needs in various regions of the country.
4. Traveled the country to provide intensive workshops and training resources.

Concrete head in front of paver during construction of unbonded concrete overlay over concrete pavement, Route 50, South Dakota

Conducted field applications program

The CP Tech Center helped several states plan and construct overlay projects. Four expert teams, consisting of representatives from the lead states, conducted the following activities:

- Made presentations to states considering concrete overlay projects; provided informational packets (including Guide to Concrete Overlays, FAQs, and booklets for Engineer and Chief Engineer).
- Visited and evaluated potential overlay sites in states considering overlay projects.
- Wrote a brief assessment report for each state based on initial meeting and site visit(s).
- Based on individual states’ needs and requests, assisted in or reviewed design, plan, and specifications development; participated in pre-construction meeting(s); made on-site visit(s) during construction; and provided other help before, during, and after construction.
- Wrote a report for every site visit and constructed project.

To date, several states have constructed or are constructing projects: Delaware, Iowa, Maryland, Nevada (in design stage), North Dakota, Pennsylvania, South Dakota, Wyoming, and Virginia (construction scheduled

July/August 2012). (Additional states are in the project planning stages.) The participating states are responsible for the following:

- Making the final site selection.
- Developing designs and plans.
- Constructing projects.

The CP Tech Center's *Final Report: Concrete Overlay Field Applications Program* will be published Aug 2012.

Conducted and promoted research

The CP Tech Center identified challenges related to concrete overlays and conducted or oversaw research projects to address them. The goal was to incorporate lessons learned from research into training activities and publications.

In general, the sponsored research projects involved the following activities:

- Constructing and evaluating overlays over asphalt-overlaid brick, asphalt-overlaid concrete, and concrete streets and roads.
- Investigating issues related to existing pavement structural and surface conditions, pre-overlay repairs and other preparation, bonded versus unbonded designs, asphalt v. geosynthetic interlayers for unbonded designs, work zones and construction under traffic, widened and tied shoulders, overlay load transfer, jointing and other tensile stress relief measures, temperature variations, use of tie bars, overlay thicknesses, performance, maintenance, and cost.

In addition, the CP Tech Center has led and coordinated research and outreach activities under Track 8 of the CP Road Map: Concrete Pavement Construction, Reconstruction, and Overlays.

Presentations and site visits were made to states considering participation in the field applications program (colored blue); to date, seven of the states have constructed or are constructing overlay projects as part of the program, with additional states in the planning stages

Developed special publications

Since 2007, the CP Tech Center has developed the following manuals, incorporating lessons learned from research, field applications program projects, and technical advisory committees:

- *Guide to Concrete Overlays* 1st and 2nd ed., 2007 and 2008, funded by CP Tech Center.
- *Guide to Thin Concrete Overlays for Joint Deterioration* to be published Aug. 2012, funded by pooled fund.
- *Guide to Concrete Overlays for Asphalt Parking Lots* to be published Aug. 2012, funded by National Ready Mix Concrete Association.
- *Guide to the Design of Concrete Overlays Using Existing Methodologies* to be published Aug. 2012, FHWA funded.

The center has also developed several technical briefs, posters, and handouts based on topics in these guides. All overlay-related publications, including project reports, technical summaries, manuals, and state site reports, are available online as soon as they are published, www.cptechcenter.org/.

Conducted national training

In addition to field application site visits, since January 2007 the CP Tech Center has conducted overlay training workshops and presentations in Arkansas, Arizona, Georgia, Hawaii, Illinois, Iowa, Indiana, Kansas, Louisiana, Michigan, Minnesota, Missouri, Nebraska, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Wisconsin, and Wyoming. The team has also made presentations to the Transportation Research Board in cooperation with FHWA's Concrete Pavement Technology Program based in Washington, D.C., and at meetings of the National Concrete Consortium in both Texas and South Dakota.

Lessons learned

Through the field applications program and research projects, many lessons have been learned that have resulted in improved practices at various stages of concrete overlay projects. Following are highlights of recommendations based on lessons learned:

Project evaluation and selection

- Utilize coring, falling weight deflectometers, and "as built" plans to investigate existing pavement layer conditions and thicknesses to determine what type of overlay is appropriate for a given roadway.
- If existing asphalt will be milled, take cores of asphalt to ensure that adequate (3–4-in.) asphalt depth will remain after milling as a design minimum and to allow concrete-loaded trucks to travel on it with minimal damage to the milled surface.
- In freeze-thaw climates and/or areas with expansive soils, evaluate existing pavement in spring and summer to identify critical pavement distresses that need to be accounted for in the overlay design.

- Identify all vertical constraints (bridges, utilities, loop vehicle detectors, curbs, barriers, ramps and driveways, guard rail, and other structures) that may impact construction and a plan to mitigate them.

Concrete overlay design

- During the early phases of design, consider all partial and full detour options and their impact on construction.
- Choose the most appropriate overlay type (bonded or unbonded) to meet existing pavement conditions and anticipated future traffic loadings.
- For unbonded overlays over concrete in non-arid climates, provide a positive drainage path for surface moisture to exit the interlayer bond breaker (separation layer), to prevent interlayer erosion under heavy traffic loadings.
- In designs for unbonded overlays over concrete, compare asphalt or geotextile interlayer (separation layer) costs, construction time, and performance.
- Determine transition lengths from the existing profile elevation to the top of the concrete overlay profile elevation on existing profile constraints, final roadway design speeds, length and type of traffic control to be used, and final open-to-traffic speeds.
- Utilize cubic yard and square yard payment items. Square yard covers placement, and cubic yard covers material, which reduces contractor risk and cost while paying for concrete used to fill surface irregularities.
- Based on construction economics and expected overlay perrformance, in designs for unbonded overlays over concrete, correct irregularities in cross-slope and profile by varying the thickness of concrete, not the depth of the asphalt bond breaker (separator layer). Deeper transverse joint sawing may be necessary to achieve T/3, but final overlay performance will be enhanced.
- In designs for bonded overlays over asphalt, exercise care when milling the asphalt to prevent leaving a thin asphalt lift, which can cause delamination.
- Consider two potential overlay quantity design options:
  1. For minimal preliminary work and cost,
     – Do no preliminary survey other than measuring wheel rut depth and pavement cross-slope at 500-ft intervals.
     – Develop design profiles of centerline and pavement edges.
     – Estimate the quantity of concrete required to meet the profiles and provide minimum thickness at centerline and edges of pavement.
     – Add a reasonable percentage to the concrete quantity to account for placement tolerance, construction losses, and surface/cross-section irregularities and establish the "new theoretical" plan quantity. Some states use 15 to 20 percent, depending on the thickness of the overlay and the amount of pavement cross-slope correction desired. The thinner the overlay and the higher the cross-slope correction, the higher the percentage. Some states add a maximum overrun of 2 to 3 percent to the "new theoretical" plan quantity.
  2. For optimization of concrete quantities,
     – Conduct nine-shot cross-sections at 50-ft intervals to map the existing surface.
     – Develop a design centerline profile and cross-slope that optimizes pavement smoothness, maintains minimum overlay depth at centerline, and optimizes concrete quantities.
     – Limit the contractor to an additional percent of the quantity identified by the desired cross-section and design profile. Some states use 6 to 8 percent, depending on the thickness of the overlay.
- Evaluate the impacts of removing/replacing medians or existing curbs versus their retention in terms of construction time, cost, and future performance.
- Carefully review the construction sequence and maintenance of traffic in conjunction with joint layout. In some cases, tied longitudinal construction joints can interfere with the maintenance of both public and contractor traffic.
- Develop the construction sequence to meet closed road or through traffic maintenance in conjunction with joint layout and design for turn lanes and shoulder concrete work.
- Develop staging plans that allow for the use of paving equipment between existing concrete railings and temporary safety-related barrier walls.
- Design transitions and bridge approach pavement sections to minimize hand placement and detailed jointing plans.
- Determine the type and amount of surface preparation required based on agency prioritization of the following goals:
  1. Pavement smoothness.
  2. Concrete quantity.
  3. Matching existing surface features.
  4. Maintaining minimum cross-slopes.
  5. Removal of unstable existing pavement layers.
  6. Vertical clearance site conditions.
  7. Bond enhancement between existing and overlay pavement layers.

Plans and specifications

- Reduce plan sets to necessary quantities, design details, plan/profile data (not sheets), and survey control information.
- Require the use of vibrator frequency monitor recorders on the paver.
- Utilize standard concrete mixes and maturity measurements to control opening of intersections and access points. Use accelerated concrete mixtures only when necessary.

- When existing surface milling is required, clearly define the purpose, vertical and cross-slope limits, and the required existing surface survey accuracy.

Sequence of construction and maintenance of traffic

- Hold a public preconstruction meeting to communicate traffic control impacts and identify public concerns that should be addressed by the contractor and highway agency during construction.
- Minimize the number of gaps for intersections and driveways, to provide for uninterrupted paving.
- Consider paving plans that allow temporary access for adjacent property owners where possible and accommodate their daily needs.
- Clearly state the criteria for lane closures and allow for contractor alternative suggestions to meet the criteria.
- Provide for alternative detour routes to be used in the case of unforeseen circumstances (crashes, wide loads, equipment breakdowns, etc.).
- Jointly with the contractor, develop a traffic control plan that allows sufficient room for construction operations and keeps the traveling public and pedestrians safe.
- Anticipate and mitigate temporary drainage issues caused by milling operations.
- In the case of construction of single-lane overlays with 24-hr pilot car operations on a two-lane road, apply the following construction suggestions:
  1. Allow multiple construction zones separated by two miles between flagger stations. The 2-mi. work zone area requirement is the distance between flagger stations versus the outermost warning signs.
  2. Consider using a 3.5-mi paving work zone and allow the contractor to close local crossings in the work zone only when those in the adjacent zone are open.
  3. Allow the contractor to propose methods and materials to construct temporary access ramps (in use for less than one month).
  4. Encourage construction of bridge work, transition sections, subdrains, pavement patching, side ditch drainage work, and earthwork prior to staged surface preparation and paving operations.
  5. Delete centerline safety wedge construction where pilot car operations are used 24/7 through the work area.
  6. Allow for equipment work on shoulders and side ditches to proceed in the same area as a lane closure employed for other prepaving work.
  7. Where bridge approaches and road intersections are immediately adjacent to each other, encourage use of extended temporary barrier rail lengths and three-leg traffic signal setups to reduce construction/traffic delays.

Concrete overlay construction

- Require contractor development of a comprehensive paving plan to address construction and public impacts.
- When necessary, accelerate all construction processes to minimize public impact. Limit contract stage work times to emphasize the need for accelerated work if that is the goal of the contract.
- Where load transfer is called for in wheel paths only, use separate partial dowel baskets for each wheel path and do NOT cut the basket shipping wires.
- When anchoring dowel baskets consider the use of uniform thicknesses of separation layer, adequate numbers of anchors, and the relationship of anchor length and shot force to the separation layer depth and material, and minimize the head of concrete in front of the paver. Monitor dowels behind the paver for location, orientation, and depth.
- Utilize software such as HIPERPAV to anticipate paving or curing problems and mitigate their impact on operations.
- Minimize the temperature differential between the existing pavement surface and the concrete overlay during placement and curing. This is especially critical during cool-weather-paving for the following reasons:
  1. When a bonded concrete overlay is placed in cooler weather, the day/night temperature differential will cause movement in the existing pavement; it will expand during the day and contract at night. To prevent cracking in the overlay, the overlay must reach saw strength before the underlying pavement's nighttime contraction. Specifying a minimum overlay mix temperature of 65°F has proven to be helpful in mitigating this set-time issue.
  2. In addition, when a concrete overlay is placed in cooler weather, the concrete can set from the bottom up, delaying the sawing window. Temporarily covering the overlay with plastic after paving helps the concrete to set properly, allowing for timely sawing.

Construction of small concrete overlay project using transit-mixed concrete and hand placement methods on US-13, Delaware

Placement of 6-in. bonded concrete overlay on SR-119, Pennsylvania