City and County Pavement Improvement Center (CCPIC)

Pavement Financial and Environmental Sustainability, Some Best Practices
Shadi Saadeh, Erik Updyke, John Harvey

City and County Engineers Association
June 4, 2020
Sponsored by League of California Cities, County Engineers Association of California, and California State Association of Counties

Chartered 28 September 2018

www.ucprc.ucdavis.edu/ccpic
Agenda

• Welcome and Introductions
• CCPIC:
  – Mission and Vision, Scope, Organization
  – Certificate Program
  – Planned Certificate Curriculum and New Course Development
• Worklist
• Technical Presentation
• Questions and Answers
CCPIC Mission and Vision

• Mission
  – CCPIC works with local governments to increase pavement technical capability through timely, relevant, and practical support, training, outreach and research

• Vision
  – Making local government-managed pavement last longer, cost less, and be more sustainable
CCPIC Organization

- University of California Partners
  - University of California Pavement Research Center (lead), administered and funded by ITS Davis
  - UC Berkeley ITS Tech Transfer, administered and funded by ITS Berkeley

- California State University Partners
  - CSU-Chico, CSU-Long Beach, Cal Poly San Luis Obispo
  - Funding partner: Mineta Transportation Institute, San Jose State University
CCPIC Organization

• Governance:
  – Chartered by League of California Cities, California State Association of Counties, County Engineers Association of California, also provide staff support
  – Governance Board consisting of 6 city and 6 county transportation professionals

• Current Funding
  – Seed funding for CCPIC set up and initial activities from SB1 funding through the ITS at UC Davis and UC Berkeley, and Mineta Transportation Institute at San Jose State University
CCPIC Scope

• Technology Transfer: training
• Technical resources: technical briefs, guidance, sample specifications, tools, and other resources
• Pavement engineering and management certificate program for working professionals: through UC Berkeley ITS Tech Transfer
• Resource center: outreach, questions, pilot study documentation, and forensic investigations
• Research and development: for local government needs that are not covered by state and federal efforts
CCPIC Training: Certificate Program

• Pavement Engineering and Management Certificate Overview
  – For engineers, asset managers, upper-level managers, technicians and construction inspectors
  – 92 hours of training
    • 60 hours in core classes, 32 hours elective
    • Majority of classes to be offered online
  – In four categories:
    • Pavement Fundamentals
    • Pavement Management
    • Pavement Materials and Construction
    • Pavement Design

Status
  – Plan approved by Governance Board
  – Initial classes being delivered, including updated TechTransfer classes and newly developed classes
# CCPIC Training: Planned Certificate Curriculum

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## CCPIC Training: New Course Development

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Worklist

• Pavement Condition Index (PCI) 4-Pager
  – A four page paper describing how PCI is measured, what it doesn’t measure, and how similar or same PCI may have different implications for pavement preservation and pavement rehabilitation strategies.

• Superpave Lite
  – Lead the development of specifications in Caltrans and Greenbook format for a Superpave specification for use by local agencies.
Worklist

• Tech Topics/Pavement Technology Updates

• Local Agency Survey
  – Working through LoCC/CEAC, conduct a survey of local agencies on the use of Superpave, interest in a Superpave specification, RAP, warm mix, and other subjects. Results will provide insight and serve as a basis for future CCPIC initiatives.
• Local Agency Survey:
  – Working through LoCC/CEAC, conduct a survey of local agencies on the use of Superpave, interest in a Superpave specification, RAP, warm mix, and other subjects. Develop a contact list of each Agency’s “go to” person. Results will provide insight and serve as a basis for future CCPIC initiatives.

• Interested in being on the “Go to” list?
  • Go to the CCPIC website or send an email to ccpic@ucdavis.edu
Greenbook Committee
Superpave Initiative

• Concept
  – Asphalt Concrete Task Force has initiated “round-robin” testing of three different Hveem mixes to equate the number of gyrations needed to produce a mix with 3% air voids. Essentially, a simplified conversion from Hveem to Superpave.
  – Results to date have been inconsistent.

• CCPIC Support:
  – Review test protocols and procedures. Make recommendations for changes as necessary.
  – Review and interpret test results.
  – Provide guidance and recommendations throughout the process.
  – Upon completion, prepare formal conclusions and recommendations.
  – Assist the Asphalt Concrete Task Force members as requested.
CCPIC Website
www.ucprc.ucdavis.edu/ccpic

- Pavement training
- Best practices technical briefs
- Tools
- Unpaved roads
- Peer-to-peer
How to get involved?

• Get training
• Get your organization to take training
• Host in-person training classes
• Read the tech briefs and see if your agency can make improvements
  – See the draft specification language
  – We can support you
• Get involved with governance board
• Start a peer-to-peer chat group
• Take a look at the tools on the website
How to figure out most cost-effective strategies: use PMS data and life cycle cost analysis

- Understanding performance of your pavements is key to good pavement management and life cycle cost analysis (LCCA)
  - Performance estimates are typically in terms of pavement condition index (PCI)
  - Agencies need to go one step behind PCI to understand performance, can do this themselves
Pavement management: 
Use of PCI vs measured cracking

- PCI is amalgamation of different distresses
- Can have same PCI for very different conditions
- Engineering meaning in the condition survey is lost
- Recommend
  - Use PCI as communication tool for management/public
  - Manage asphalt pavement considering:
    - Cracking: age and traffic caused
    - Other distresses (rutting, raveling)
- CCPI working on Tech Brief regarding use of PCI and cracking data
**CASE 1: TRAFFIC LOADING RELATED, PCI = 34**

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<th>QUANTITY</th>
<th>DV</th>
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<tr>
<td>Alligator Cracks</td>
<td>Medium</td>
<td>1x4 1x5 1x7</td>
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<tr>
<td>Rutting</td>
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**CASE 2: AGE, CONSTRUCTION, UTILITIES, OTHER FACTORS, PCI = 32**

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<th>SEVERITY</th>
<th>QUANTITY</th>
<th>DV</th>
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<td>Long/Trans Crack</td>
<td>High</td>
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<tr>
<td>Long/Trans Crack</td>
<td>Medium</td>
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<tr>
<td>Patching/Utility</td>
<td>High</td>
<td>25x4 25x2</td>
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<tr>
<td>Patching/Utility</td>
<td>Medium</td>
<td>12x6 4x7</td>
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<tr>
<td>Block Cracks</td>
<td>High</td>
<td>4x6 6x5</td>
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Variables in the PCI for asphalt pavement

- Fatigue cracking and potholes caused by **heavy loads**:
  - Alligator cracking
  - Potholes
- Cracking caused by **aging**:
  - Block cracking
  - Joint reflections
  - Longitudinal and transverse cracking

- **Other distresses**
  - Low ride quality
  - Bleeding
  - Bumps and sags
  - Corrugations
  - Depressions
  - Edge cracking
  - Lane/shoulder drop-off
  - Patching and utility cut patching
  - Polished aggregate
  - Rutting
  - Shoving
  - Slippage cracking
  - Swelling
  - Weathering and raveling
Bottom Up Fatigue Cracking

- Interaction of asphalt concrete layer, support of underlying structure, materials selection, construction compaction
- Traffic loading
  - Only the truck loads count, cars are too light
  - slower speeds = longer durations = bigger strains
- Environment
  - temperature
  - water sensitivity
  - aging
Initial Wheelpath Cracking (transverse or longitudinal)

- Distress descriptions can be seen in FHWA Distress Identification Manual
Fatigue Cracking in Wheelpaths
Treatment for load related fatigue cracking

- Fatigue cracking becomes alligator cracking, and eventually forms potholes.
- Surface treatments will slow a little, but mostly helps with block cracking, not fatigue.
- Will need to do periodic mill and fill with digouts of localized deep cracking.
- Mill and fill may not be cost-effective once alligator cracking is extensive.
  - Consider partial-depth or full-depth reclamation (FDR) cold in-place recycling depending on crack depth.
- Do not let wheelpath cracking become extensive or must reconstruct.

Extensive and likely deep alligator cracking, starting to form potholes.
**Aging of the Asphalt**

- **Aging of the asphalt**
  - Caused by oxidation, volatilization
  - Faster if high permeability and temperature
  - Permeability greatly reduced with better asphalt compaction

- **Effects**
  - Stiffening of mix with time
  - Won’t relax stresses from thermal contraction as well

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![Graph showing aging of asphalt](image)

**Aging**

- Mostly done by 5 years after placement
- 2 to 5 times stiffer, much more elastic, less viscous
Block Cracking

- Typically caused by long-term aging of asphalt concrete and daily temperature cycling (expansion/contraction)
- May also be reflection cracking from shrinkage cracks in cement treated base
- Poor asphalt construction compaction allows air to enter and age the asphalt faster, accelerates aging

Good compaction limits entry of air and slows oxidation
Block Cracking

Top down cracking

Lgam.wdfiles.com
Treatment for age-related cracking

- Keep the surface protected from aging
- Can potentially use perpetual fogs, slurries or microsurfacings
  - Use appropriate treatment for HMA or RHMA
- What frequency?
  - After aging has progressed
    - About 7 to 12 years
  - Before cracking starts
    - Do not let cracking get extensive
  - Doing more frequently than needed can be a waste
Questions to ask when identifying the next treatment:

- Are the cracks due to fatigue in the wheelpaths (traffic), or aging of entire surface (environment), or both?

- Is the network-level strategy in the PMS appropriate for the types of cracking?

- Did the last project on the same route perform as expected? If not:
  - What’s changed?
  - Is the structural section adequate?
  - Was a thorough project-level investigation, associated testing, and calculations performed?
  - Was the appropriate strategy selected?
  - What binder was used? Should a modified binder (polymer, asphalt-rubber) be used in the next project (particularly useful if inlay/overlaying cracking)?
Pavement “MRDI” Input for Selecting Next Treatment

- **M = Materials:** What is the structural section composed of? Subgrade, base material type and thickness, HMA/AC (gradation, binder type, thickness).

- **R = Review:** Completed projects at 3, 5, and 10-year milestones.

- **D = Desktop:** As-built plans, material testing records, traffic counts, traffic index calculations/projections, inspector records, change orders.

- **I = Investigation:** Was a project-level site investigation performed? Borings, Cores, Dynamic Cone Penetrometer (DCP), Falling Weight Deflectometer (FWD), Testing (SE, R-Value/CBR, PI).
Life Cycle Cost Analysis

- Net present value = add up the costs over the analysis period, including discount rate
- Equivalent Uniform Annual Cost, spread NPV over time, with discount

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<th>Initial</th>
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<td>$ (User Costs)</td>
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Salvage Value

Analysis Period

Years
Effect of asphalt construction compaction on axle loads to cracking

- Use a quantitative (QC/QA) specification to measure compaction
- Write spec in terms of \textit{in-place bulk density} and \textit{theoretical maximum density} (TMD) and not \textit{laboratory theoretical maximum density} (LTMD)
- Use cores or nuclear gauges calibrated for the specific mix/project to provide daily feedback to contractor and agency
- Apply payment reductions if they don’t meet your specification, \textbf{and enforce those payment reductions}
- Future change to the Greenbook, Change No. 301SM, will incorporate CCPIC recommendations for asphalt compaction

\textbf{General rule:} \\
1% increase in constructed air-voids = 10% reduction in fatigue life
But what about?

• Won’t this increase the bid cost for my asphalt?
• Isn’t the cost of managing this specification high?
• Won’t coring damage my new pavement?
• What can I do to help my contractors meet and exceed the specification and further increase the life of my overlays?
Life cycle cost analysis results

effects of asphalt compaction

Compaction effect, continuous rehab strategy
(1 ln mile)

- $426,086, 6% AV Good compaction
- $468,291, 9% AV Usual practice
- $584,559, 12% AV Bad compaction
Main Takeaways

• Ability to make good engineering decisions regarding timing and type of treatment based only on PCI is limited; use the cracking data

• Life cycle cost analysis (LCCA) practical tool to determine most cost-effective strategies
  – Needs good performance estimates, agencies can use their own information
  – Focus on cracking, separated by:
    • Streets with heavy trucks/buses, wheelpath fatigue cracking and age related cracking, need rehabilitation eventually
    • Streets with no heavy vehicles, age related cracking only, can use only preservation treatments if timely

• Good asphalt compaction specification is most cost-effective change
  – 92% relative to theoretical maximum density not laboratory maximum density
  – Must be effectively enforced to work

• There are other things that can be done: see CCPIC training
CCPIC LCCA Excel tool

- Excel tool to calculate Net Present Value, Salvage Value and Equivalent Uniform Annual Cost
- Can compare 3 scenarios side by side
- Can choose and edit the list and sequence of treatments

So what can be done to make pavements more sustainable?

- FHWA Sustainable Pavements Task Group
  - Covers everything about pavement and sustainability
    - Cost
    - Environment
    - They usually go together
  - Tech briefs and webinars
- Google “FHWA sustainable pavement”
