City and County Pavement Improvement Center

Effective Pavement Program Management

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City and County Engineers Association

Los Angeles

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 pavements last longer, cost less, and be more sustainable

City and County Pavement Improvement Center

Sponsors

League of California Cities, County Engineers Association of California, and the California State Association of Counties

Chartered September 28, 2018

University of California Partners

University of California Pavement Research Center (lead)

UC Berkeley ITS Tech Transfer

California State University Partners

CSU-Chico, CSU-Long Beach, Cal Poly San Luis Obispo; Mineta Transportation Institute (SJSU)

CCPIC Organization

- **Governance**
  - Governance Board consisting of 6 city and 6 county transportation professionals (Carlos Castellanos, City of Anaheim is on the Board)

- **Current Funding**
  - Seed funding from SB1 through:
    - Institute of Transportation Studies at UC Davis, UC Berkeley, UC Los Angeles, UC Irvine
    - Mineta Transportation Institute at San Jose State University

CCPIC Scope

- **Technology Transfer:**
  - Training courses
  - Pavement engineering and management and construction inspection certificate programs for working professionals through UC Berkeley ITS Tech Transfer
  - Outreach
- **Technical Resources:**
  - Technical briefs, guidance, sample specifications, tools, and other resources
- **Resource Centers:**
  - Outreach, questions, pilot study documentation, and forensic investigations
- **Research and Development:**
  - For local government needs that are not covered by State and Federal efforts
  - Adapting work done for Caltrans

Pavement Engineering & Management (PEM) Certificate Program

- **PEM Certificate Program Overview**
  - For engineers, asset managers, upper-level managers, technicians and construction inspectors
  - 88.5 hours of training
    - 56.5 hours in core classes, 32 hours in electives
    - Majority of classes to be offered online
  - In four categories:
    - Fundamentals
    - Management
    - Materials and Construction
    - Design

Pavement Construction Inspection (PCI) Certificate Program

- **PCI Certificate Program Overview**
  - For engineers, material testing technicians and construction inspectors
  - 80.5 hours of training
    - 68.5 hours in core classes, 12 hours in electives
    - Majority of classes to be offered online

Pavement Distresses

Identifying Distress Types to Better Manage Asphalt Pavement

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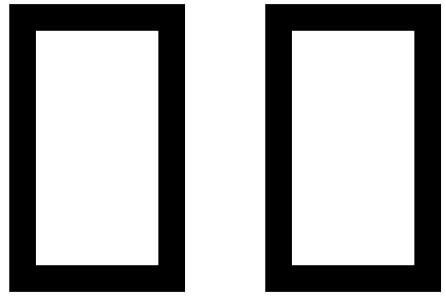
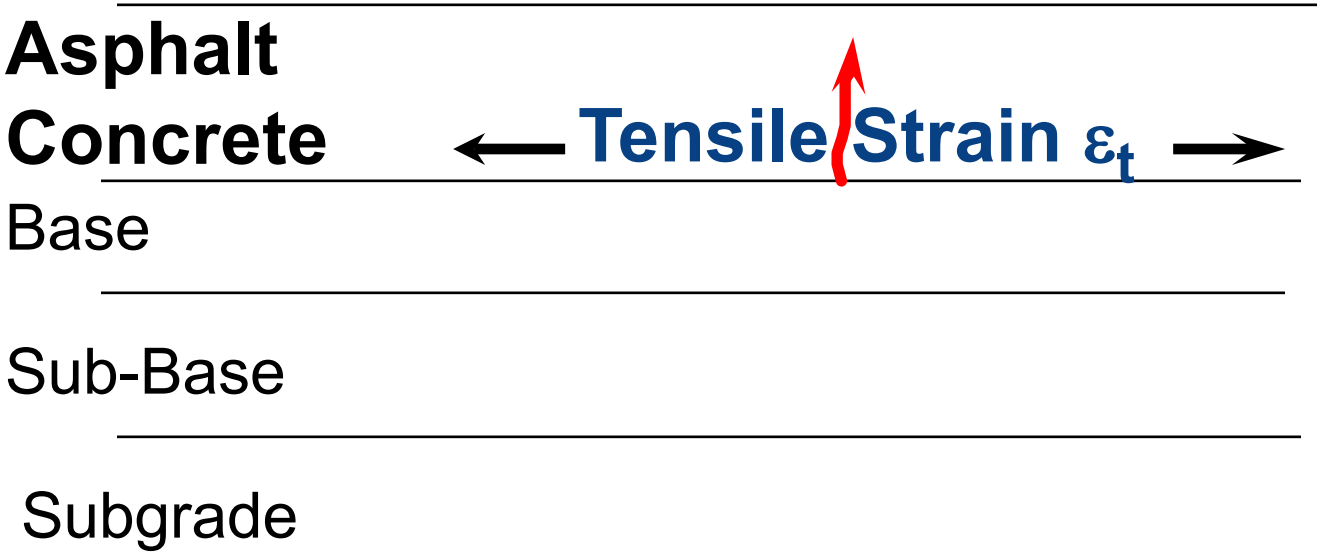
Heavy Vehicle Related Cracking

only affects the wheelpaths of pavements where heavy trucks and buses

Bottom Up Fatigue Cracking

At ***moderate*** temperatures, tensile strains under loading





Load-Related: 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

Wheel Path (Fatigue) Cracking

Initial: May be transverse or longitudinal

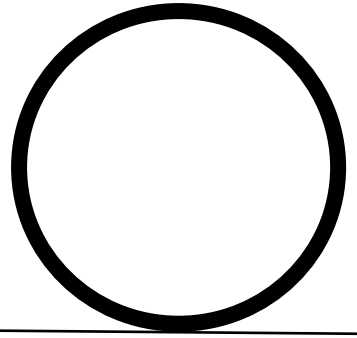
Cracks connect: alligator pattern

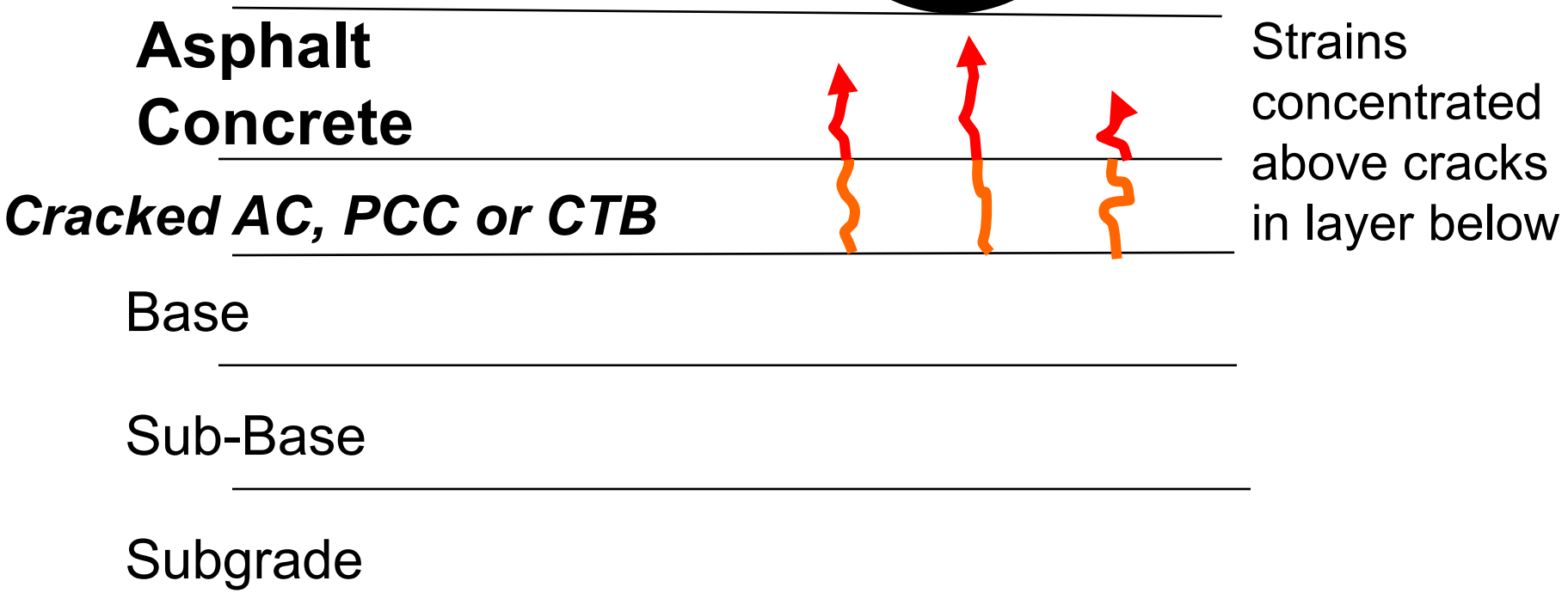
Fatigue Cracking in Wheel Paths

- Distress descriptions can be seen in the ***FHWA Distress Identification Manual***

Reflective Fatigue Cracking

- Shear and tensile strains from loads passing over, tensile strains from thermal contraction
- Crack pattern resembles pattern before overlay





Reflective Cracking of Underlying Block Cracking and Longitudinal Joint, 7 Years Old

- **Avoid putting longitudinal joints in the wheel paths!**

Load-Related Fatigue Cracking: Strategies

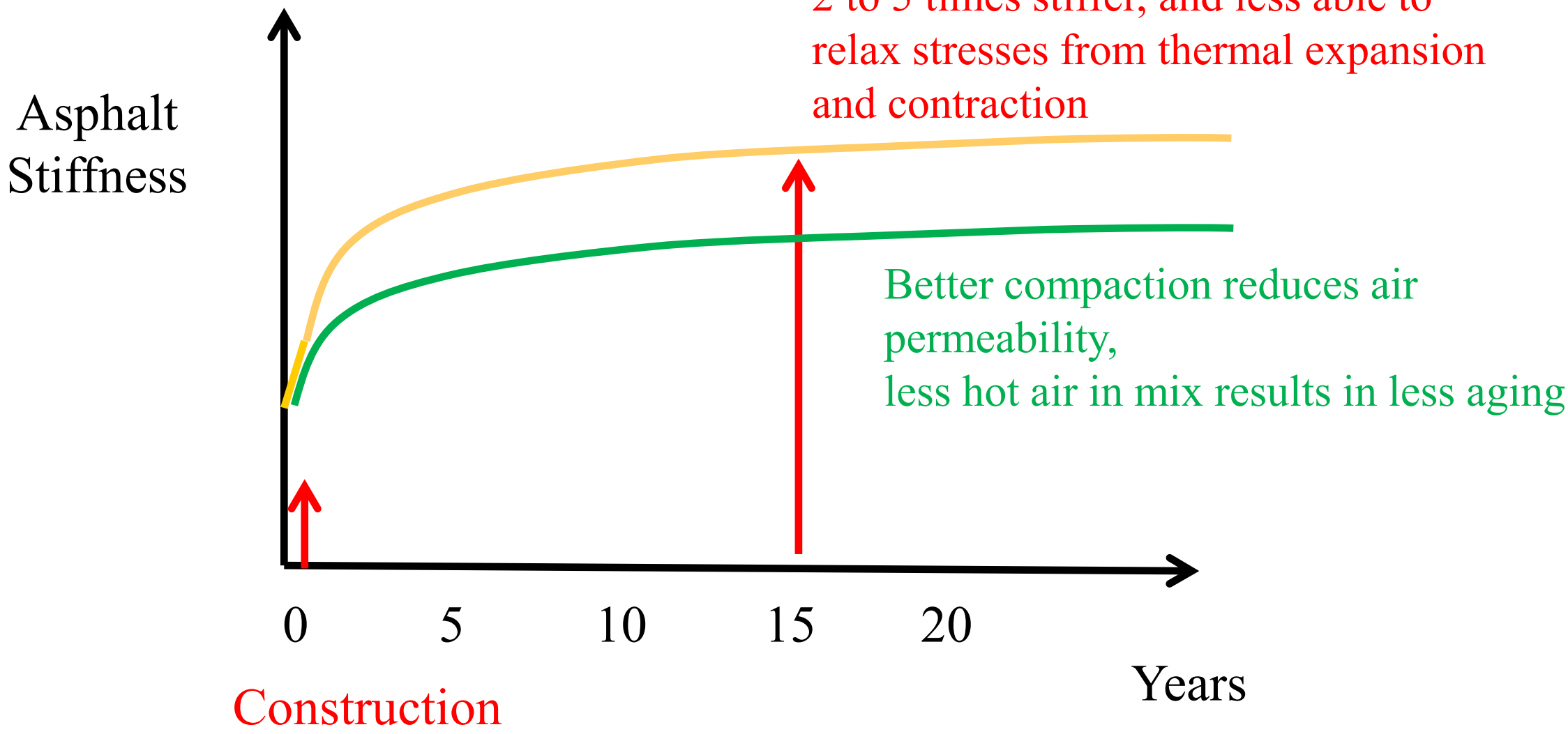
- Compaction is critical, 1% decrease in density reduces fatigue life by 10-15%
- Fatigue cracking becomes alligator cracking, and eventually forms potholes
- Surface treatments will slow a little, but mostly helps with block cracking, not fatigue
- Will need to do periodic mill and fill with digouts of localized deep cracking
- Mill and fill may not be cost-effective once alligator cracking is extensive
  - Consider partial-depth (cold in-place recycling) or full-depth reclamation (FDR) depending on crack and rutting depth or replace all or part of asphalt
- Use softer mixes for thin (<3 inch) inlays and overlays like softer HMA, RHMA-G, HMA-PM; use stiffer mixes below the surface if thicker than 3 inches

Age Related Cracking

affects all the surface
of all pavements

Aging

Amount of aging depends on asphalt chemistry, construction compaction, modifiers



Aging of the Asphalt Binder and its Effects

- **Effects of Aging**
  - Increase in stiffness
  - Asphalt cannot relax tensile stresses from thermal contraction
- **Good Compaction**
  - Less than 8% air-voids
  - Must have a compaction specification that requires density measurement with nuclear gauge or cores
  - 8% air-voids means 92% of TMD (AASHTO T 209) or 96 to 97% of LTMD (per current Greenbook)
- **Consequences**
  - Each 1% decrease in density (increase in air-voids shortens fatigue cracking and age-related cracking life by 10%

Good compaction limits entry of air and slows oxidation, provides better fatigue resistance

Block Cracking

- **Block cracking is top-down**

Age-Related Cracking: Strategies

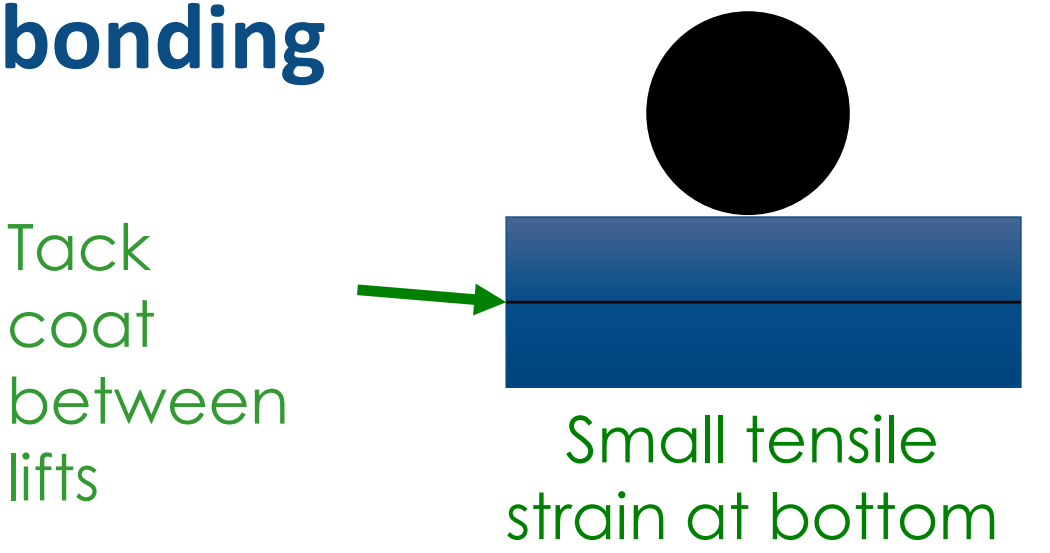
- Keep the surface protected from aging
- Can potentially use perpetual fog seals, or slurry seal or micro surfacings
  - Slurry seal typically not applied to RHMA/ARHM
- What frequency?
  - After aging has progressed, before cracking starts
    - About 4 to 12 years
    - Depends on climate, compaction, asphalt binder source
  - Doing more frequently is not cost-effective

Moisture Damage

- Layer 1 AV=13%
- Layer 2 AV=6.3%
- Water entered Layer 1, trapped between layers

Tack coats between asphalt layers: Effects of bonding and no bonding

- Asphalt layers are well bonded:
  - All layers resist bonding together
- Asphalt layers not well bonded:
  - Each layer bending by itself
- Lack of bonding can cut fatigue life in half
- Encourage proper application by making tack coat a separate Bid Item



Pavement Condition Index (PCI) and Strategy Selection in PMS

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Choosing Cost-Effective Strategies: Use of PMS Data and LCCA

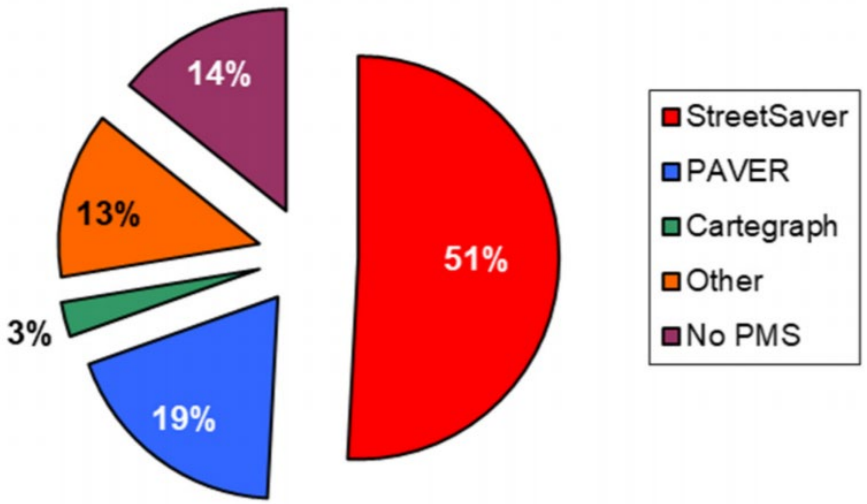
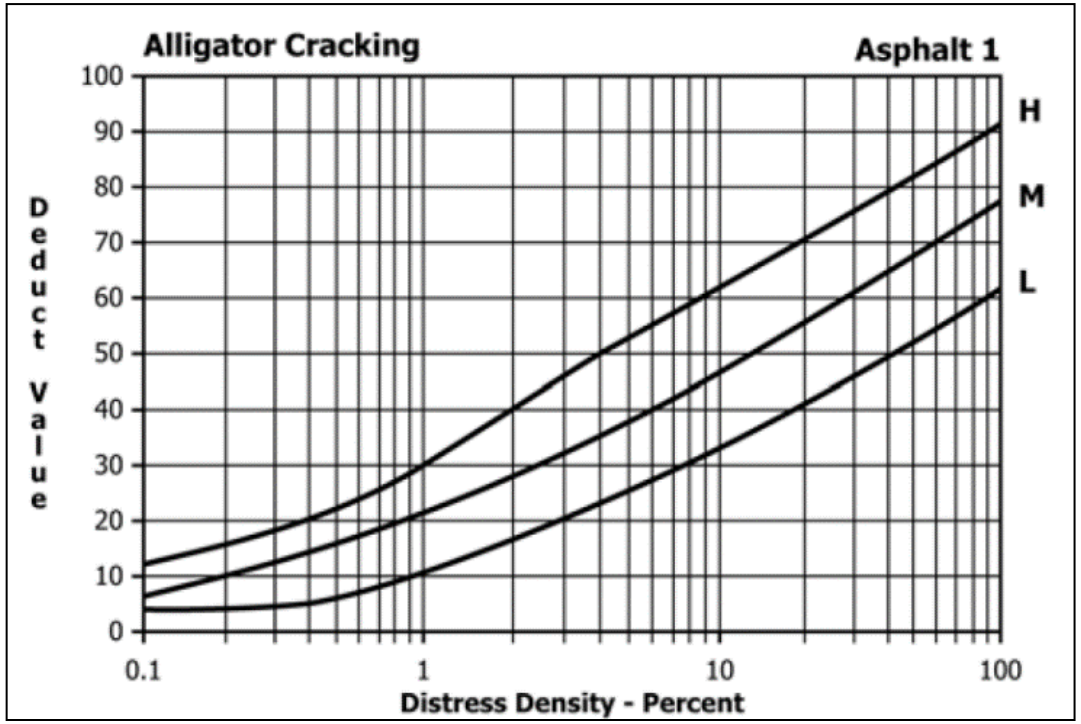


Figure B.4 PMS Software Used By Cities And Counties

- Understanding the performance of your pavements is key to good pavement management and life cycle cost analysis (LCCA)
- ***Pavement condition*** is typically calculated and described in terms of pavement condition index (PCI)
- Agencies need to take one step back behind PCI to better understand ***pavement performance*** in order to better understand PMS data and make better strategy decisions

Pavement Condition Index (PCI)

- **Calculation:**
  - *"An equation converts the severity and extent of each distress into a so-called "deduct value"; different deduct equations are used for the different distress types*
  - *All the deduct values obtained across all the distress types are then added up and subtracted from 100*
  - *The result is a PCI on a scale of 0 to 100"*



Variables in the PCI

- **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

Same or Similar PCI:
Different Distresses = Different Strategies

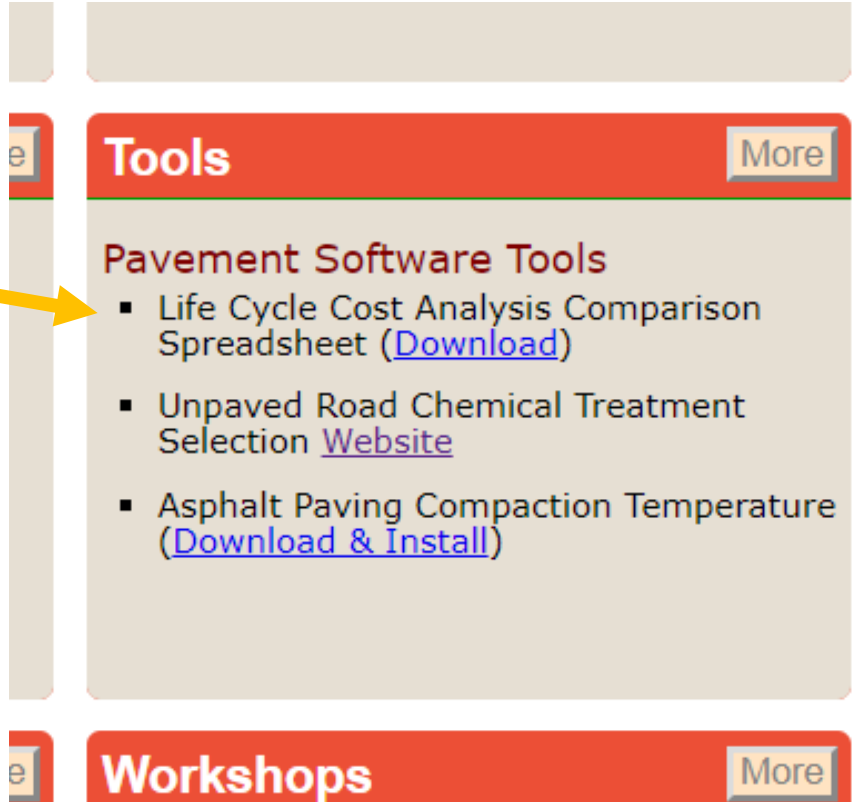
CASE 1: TRAFFIC LOADING RELATED, PCI = 34			
DISTRESS	SEVERITY	QUANTITY	DV
Alligator Cracks	High	1x6	18
Alligator Cracks	Medium	1x4 1x5 1x7	17
Potholes	Medium	3	48
Potholes	Low	3	30
Rutting	Low	2x5 2x8	10
CASE 2: AGE, CONSTRUCTION, UTILITIES, OTHER FACTORS, PCI = 32			
Long/Trans Crack	High	15 20 8 6 12 18 6x7	43
Long/Trans Crack	Medium	25x2 18 13 9 10	20
Patching/Utility	High	25x4 25x2	40
Patching/Utility	Medium	12x6 4x7	20
Block Cracks	High	4x6 6x5	13

Pavement Condition Index (PCI)

- **Problems and Limitations:**
  - *"… it has **limitations as an engineering tool** for local governments making pavement management decisions."*
  - *"Specifically, when a PCI is developed from condition survey data, **a lot of important engineering information is lost**, particularly data regarding cracking."*
  - *"A major deficiency in PCI is that roadway segments **can have the same or similar PCI [a tie score] but very different types of distress**."*
- **Recommendation:**
  - *Identify heavy vehicle routes*
  - *Use the wheelpath and age-related cracking data behind the PCI to consider appropriate treatments for each cracking type in PMS*
  - *Use life cycle cost analysis (LCCA) to find those appropriate treatments*

CCPIC LCCA Excel Tool

- Excel tool to calculate Net Present Value, Salvage Value and Equivalent Uniform Annual Cost
- Can choose and edit the list and sequence of treatments
- Use your own cost and performance data for different treatments
- CCPIC has a class on LCCA



Questions to Ask

- For the PMS
  - Is the network-level strategy in the PMS appropriate for the types of cracking?
  - Are heavy vehicle routes identified and considered in decision trees?
  - Is time since last surface treatment identified and considered in decision trees?
- For the segment
  - Time since last surface treatment?
  - Are the cracks due to fatigue in the wheel paths (traffic), or aging of entire surface (environment), or both?
  - Did the last project on the same route perform as expected? If not:
    - Consider structural section adequacy, drainage
    - Do thorough project-level investigation, associated testing, calculations performed?

Takeaways

- The ability to make good engineering decisions regarding the timing and type of strategy based only on PCI is limited
  - Focus on cracking, separated by:
    - Streets with heavy trucks/buses, wheel path fatigue cracking and age related cracking: will need rehabilitation eventually
    - Streets with no heavy vehicles, age related cracking only: can use only preservation treatments if timely
- Poor asphalt compaction or lack of tack coats can cut asphalt life in half
- Life cycle cost analysis (LCCA) is a practical tool to determine the most cost-effective strategies:
  - Needs good performance estimates, agencies can use their own information

Summary of Technical Resources

CCPIC website: www.ucprc.ucdavis.edu/ccpic

Questions?

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