Composite Pavement Systems: SHRP2 R21 Study

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This project focuses on two applications of intentionally designed composite pavement systems:
1. Asphalt over concrete (JPC, CRC, RCC)
2. Concrete surface over concrete (JPC) - wet on wet
Renewal Mission: “Get in, Get out, Stay out”

– Lower layer (PCC)
  – Primary structural layer
    – designed for minimal fatigue damage (perpetual pavement)
  – Produces long-lived structure
– Can be designed with lower cost materials (aggregates, cement content, etc.)
R21: Composite Pavements and SHRP2 Renewal

Renewal Mission: “Get in, Get out, Stay out”

– Upper layer (HMA or PCC)
  – Primarily a functional layer
  – Can be rapidly renewed (if needed) with minimal disruption to traffic
    – Retexturing (grinding for PCC)
    – Remove and replace surface layer (for HMA)
– Higher quality materials (aggregate, binder, cement content, etc.) for increased life
– Good surface characteristics (high smoothness, high friction, low noise)
R21: Project Objectives

– Determine the behavior and identify critical material and performance parameters
– Develop and validate mechanistic-empirical performance models and design procedures consistent with the Mechanistic-Empirical Pavement Design Guide (MEPDG)
– Recommend specifications, construction techniques and quality management procedures and guidelines
2008 European Survey of Composite Pavements

- Netherlands
- Germany
- Austria

Report published as an online document

R21: MnROAD Test Sections

- Full-length two-lane test sections constructed at MnROAD in Albertville, MN on Interstate 94
- Construction in April/June 2010, open to traffic in July 2010
- Currently being monitored (instrumentation, field surveys, other field testing)
Paving Wet-on-Wet PCC/PCC (MnROAD)

1st Paver: Lower JPCP RCA Layer

2nd Paver: Upper EAC Layer
MnROAD Construction: Two Paver PCC Placement

Upper Layer

Lower Layer
UCPRC HVS Test Sections

- 12 45-ft 1-lane wide test sections
- Monitored (instrumentation) and tested with the HVS
- Channelized half-axle dual-wheel loading – rutting, reflection cracking, PCC fatigue cracking
Illinois Tollway Ramps

- 2 1-lane ramps HMA/PCC
- Low traffic
- Several sustainable features
  - WMA Surface Layer
  - Flyash (20-25% replacement) in PCC
  - 30% RAP replacement in PCC
  - 10% RAP replacement in WMA mix
Composite Pavements: Field Section Example

• Urban streets in Columbus, Ohio
• Low to moderate traffic
• JPC or RCC for bottom PCC layer
• Saw and seal joints
• Very economical pavement with good structural capacity
• Easy to maintain (especially for utility cuts)
Composite Pavements: Field Section Example

- High volume Interstate 10 in San Antonio, TX
- Widening of existing CRC pavement with HMA/CRC and overlay of existing CRC
- 25 years of heavy traffic
Composite Pavements: Field Section Example

- High volume Tollway Interstate 294 in Chicago, IL
- Widening of existing JPC pavement with HMA/JPC and overlay of existing JPC
- 10+ years of heavy traffic
Composite Pavements: Field Section Example

- Moderate volume Interstate 64 in Fairview Heights, IL
- Widening of existing CRC pavement with HMA/CRC and overlay of existing CRC
- 5+ years of moderate traffic
Composite Pavements: Field Section Example

- Moderate truck volume rural Interstate 70 in Kansas
- PCC/PCC 2-lift paving with various surface textures
- Constructed in 2007
Composite Pavements: Field Sections

- **HMA/PCC**
  - Arizona
  - Washington
  - New York City
  - Columbus, OH
  - Ohio
  - Illinois
  - Texas
  - Virginia
  - Oregon
  - North Carolina
  - Ontario

- **PCC/PCC**
  - Michigan
  - Florida
  - Kansas
  - Additional states considering construction in future
Sustainable Construction: PCC Recycling

- 50% coarse aggregate RCA used at MnROAD for lower lift of PCC pavement
Sustainable Construction: Thinner Upper Lift

- Thinner upper lift of quality aggregates potentially reduces amount of aggregate that need to be hauled over long distances.
Sustainable Construction: RAP in PCC

- 30-50% coarse aggregate RAP used at Illinois Tollway for lower lift of PCC pavement
Sustainable Construction: WMA Upper Lift

- WMA used at Illinois Tollway for upper lift HMA (Evotherm J1 additive)
- Heated to a lower temperature (~60 to 90 °F reduction) compared to conventional HMA.
- Lower temperatures mean less fuel consumption, lower stack emissions, and less fume and odor generation at the plant and job site.
Sustainable Construction: Low Noise

- Porous rubberized HMA in AZ, Netherlands
- Exposed aggregate concrete (EAC) at MnROAD, in Austria, Germany, and Kansas
- Durable diamond grind/groove texture (next generation) at MnROAD
Sustainable Construction: Fly Ash in lower PCC

- 60% fly ash replacement at MnROAD for lower lift of PCC pavement
- 25% fly ash replacement at IL Tollway for lower lift of PCC pavement
- Fly ash is a by-product of coal-fired electric generating plants.
- The use of RAP, RCA, and fly ash offers environmental advantages by diverting the material from the wastestream, reducing the energy investment in processing virgin materials, conserving virgin materials, and minimizing pollution.
## R21: Products

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<th>Product</th>
<th>Difference?</th>
<th>Benefits</th>
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| MEPDG ver. R21; MOP Revisions; LCCA Guidelines & Examples | First and only procedure for the design of new composite pavements | - Another tool in pavement design engineers’ arsenal (for pavement type selection)  
- Will encourage pavement designs that are long lasting and can be rapidly renewed – consistent with SHRP2 Renewal philosophy of “get in, get out, stay out” |
| Constr. Specs. Constr. Guidelines & QM Procedures Material Guidelines | No current guidelines or specs. for constructing new composite pavements | - Agencies considering constructing composite pavements will not need to develop specs. and guidelines on their own but can adopt the products of this research |
| Training Materials Design Examples Short Video Clips, Case Studies | Packaged for quick and easy implementation of the design and construction products (Webinars) | - All relevant design and construction issues included in these materials  
- Training of agency and contractor personnel is key to adoption and widespread use of composite pavements |
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<td>Final ReportAppendices, European Report*</td>
<td>First state-of-the-art products for designing and constructing composite pavements</td>
<td>• The reports and databases will add substantially to the state of the art and will be very valuable for future research and analysis</td>
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<td>Database of Sections</td>
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<td>MnROAD Test Sections UCPRC HVS Test Sections</td>
<td>One of a kind instrumented test sections (with various design features)</td>
<td>• Future researchers can use the data obtained from future monitoring and testing of these test sections to further the state-of-the-art and the state-of-the-practice for designing and constructing composite pavements</td>
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Thank You