ICT Update for
49th Annual Illinois Bituminous
Paving Conference

December 3, 2008
ICT Vision

- Serve the transportation needs of IDOT, the State of Illinois, and the nation through research, education, and outreach
  - Rapid response to future scientific challenges in transportation
  - Adapt to changing needs
- Develop and implement innovative and cost-effective technologies
- Optimize the limited resources of IDOT
ICT Growth

Millions

2006 2007 2008 2009 2010 2011

Fiscal Year

2006 2007 2008 2009 2010 2011

- 1 2 3 4 5 6

ILLINOIS CENTER FOR TRANSPORTATION
Initial Projects, 2005

- Pavements: 9 (76%)
- Structures: 1 (8%)
- Safety: 1 (8%)
- Traffic Ops./Maintenance: 1 (8%)
Initial Funding by Focus Area (2005)

- Pavements: $2.25M (69%)
- Structures: $0.28M (8%)
- Safety: $0.31M (9%)
- Traffic Opns. & Maint.: $0.44M (14%)
Transportation Diversity!

- Pavements: 20 (25%)
- Traffic Ops./Maint.: 11 (14%)
- Safety: 10 (12%)
- Environment: 5 (6%)
- Public Trans.: 7 (9%)
- Planning: 6 (7%)
- Construction: 2 (2%)
- Other: 3 (4%)
- Structures: 17 (21%)
New Funds by Focus Area

- Pavements: $3.0M (24%)
- Traffic Opns. & Maint.: $1.4M (11%)
- Structures: $3.1M (24%)
- Safety: $1.8M (14%)
- Public Trans.: $0.5M (4%)
- Environment: $0.7M (5%)
- Other/Dept.-wide: $1.1M (9%)
- Planning: $0.6M (5%)
- Construction: $0.5M (4%)
ICT Funds Available, Committed and Remaining by Year

<table>
<thead>
<tr>
<th>Year</th>
<th>Total ICT Funds Available</th>
<th>Funds Committed to Date</th>
<th>Funds Remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>$12M</td>
<td>$4M</td>
<td>$8M</td>
</tr>
<tr>
<td>2010</td>
<td>$14M</td>
<td>$6M</td>
<td>$8M</td>
</tr>
<tr>
<td>2011</td>
<td>$16M</td>
<td>$8M</td>
<td>$8M</td>
</tr>
<tr>
<td>3-Yr. Total</td>
<td>$48M</td>
<td>$18M</td>
<td>$30M</td>
</tr>
</tbody>
</table>

Fiscal Year:
- 2009
- 2010
- 2011
- 3-Yr. Total

M = Millions
Research Progress/ Status

- **Total Projects Approved to Date = 93**
  - 81 Regular Projects – Selected by Exec. Committee
  - 12 Special (Short-Term) Projects

- **24 Projects Are Completed**
  - 16 Regular Projects
  - 8 Special (Short-Term) Projects

- **24 ICT Reports Published on Website**

- **69 Active ICT Projects**
Outsourcing Growth

- **Initial Project List in August 2005**
  - IDOT-UIUC Agreement
    - 12 UIUC Projects/ $3.3M
    - 0 Outsourced Projects
- **81 Project Additions (12/05 - 11/08)**
  - 59 UI Projects/ $10.3M
  - 22 Outsourced Projects/ $2.2M
Who’s Participating in ICT?

- 40 Academic Researchers (PI’s/ Co-PI’s)
- 50 Graduate Students
- 9 Universities
- 4 Private Consulting Firms
- 2 Federal/ Local Gov’t. Agencies
- Consultants
Research Need Selection

Technical Advisory Groups (TAGs)

Executive Committee

Bureau of M & PR

Traffic/Roadside
Structures & Bridges
Public Transportation
Environment
Pavement & Materials

Safety
Planning
Construction
Ad Hoc TAG's (as needed)

Technical Review Panels (for each project)
Served by a Top Facility - ATREL
Materials Testing Laboratory
Modeling
Accelerated Transportation Loading ASsembly (ATLAS)
ATLAS Upgrade
<table>
<thead>
<tr>
<th>Pub No</th>
<th>Proj No.</th>
<th>Title</th>
<th>Authors</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHWA-ICT-09-022</td>
<td>ICT-R27-23</td>
<td>Non-destructive Pavement Analysis Using ILLI-PAVE Artificial Neural Network Models</td>
<td>Orna Pelcan, Edl Tutumluer, Marshall Thompson</td>
<td>Sep-08</td>
</tr>
<tr>
<td>FHWA-ICT-09-028</td>
<td>ICT-R55</td>
<td>Track Coat Optimization for HMA Overlays: Laboratory Testing</td>
<td>Imed L. Al-Gaifi, Samuel H. Carpenter, Zhen Leng, Hassan Ozer, James S. Trepawan</td>
<td>Sep-08</td>
</tr>
<tr>
<td>ICT-08-024</td>
<td>ICT-R43</td>
<td>Evaluation of Video Detection Systems, Volume 1 - Effects of Configuration Changes in the Performance of Video Detection Systems</td>
<td>Juan C. Medina, Rahim F. Bevakohal, Madhav Chitturi</td>
<td>Sep-08</td>
</tr>
<tr>
<td>FHWA-ICT-09-017</td>
<td>ICT-R39</td>
<td>EXTENDED LIFE HOT MIX ASPHALT PAVEMENT (ELHMAP) TEST SECTIONS AT ATPEL</td>
<td>S.H. Carpenter</td>
<td>Jul-08</td>
</tr>
<tr>
<td>FHWA-ICT-09-018</td>
<td>ICT-R27-16</td>
<td>Truckers' Park/Rest Facility Study</td>
<td>Peter Beltemacchi, Laurenco Rohier, Jon Salinsky, Terry Manning</td>
<td>Jul-08</td>
</tr>
<tr>
<td>FHWA-ICT-09-019</td>
<td>ICT-R27-17</td>
<td>Carbon Monoxide Screen for Signalized Intersections COSIM, Version 3.0</td>
<td>Scott Peters</td>
<td>Jul-08</td>
</tr>
</tbody>
</table>
Quarterly ICT E-Newsletter

- Redesigned early 2008; emailed in February, May, August, November.
- Covers ICT, UIUC, and IDOT news, including project updates, publication updates, RFP posting, transportation conferences, etc.
- Broad mailing list includes IDOT associates, UIUC alumni, international contacts, other transportation centers, many more.
Online/ Electronic Initiatives

Examples of Initiatives In Progress:

- Online Research Needs Submission
- Online Reporting of Project Progress
- Automated Quarterly Progress Reports
- Online Registration/Payment for Continuing Education Classes/ Short Courses
- More Online Meetings & Training
Examples of Current ICT Projects

- **Green Technology:** Pavement Recycling & Rehabilitation
- **Traffic/ Engineering Safety:** Nighttime Construction; Speed Photo-Enforcement
- **Secure Bridges:** Chicago Bridge Assessment
- **Renewal Energy:** Wind Energy
- **Training Initiatives:** Documentation of Contract Quantities
Evaluation/ Optimization of Tack Coat & Bond of HMA Overlays of PCC

- The effectiveness of tack coat application between existing PCC pavement and HMA overlay was quantified through lab testing and accelerated pavement testing (APT).

- **Outcome:** Optimized tack coat type and application rate.

- **Status:** Lab testing report is available on ICT website; APT report is being finalized.
Laboratory Testing

- A specially designed direct shear testing fixture was used.
- Experimental variables include tack coat type, tack coat application rate, HMA type, temperature, and moisture.
Accelerated Pavement Testing (APT)

- Thermocouple
- Strain Gauge
- Surface Profile Measurement

ATLAS Test 1
(Total Length= 12.5'x5'=62.5')

ATLAS Test 3
(Total Length= 12.5'x6'=75')

ATLAS Test 5
(Total Length= 12.5'x5'=62.5')

ATLAS Test 2
(Total Length= 12.5'x4'=50')

ATLAS Test 4
(Total Length= 12.5'x4'=50')

- Indicaes a milled surface that is broom cleaned only.
- Indicates a milled surface that is thoroughly cleaned with an air blast.

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Field Tack Coat Application

Centennial variable-bar liquid distributor

Geotextile pad for tack coat application rate measurement
Research Outcome

- Lab and field testing results suggest that asphalt emulsion provides better interface bonding than cutback; no significant difference between SS-1hP and SS-1h.
- From lab testing, optimum residual tack coat application rate is 0.04 gal/yd². This value was validated in the field.
- Lab testing results showed that temperature and moisture affected interface shear strength.
- How to improve bonding:
  - Mill PCC surface
  - Clean PCC surface
  - Uniform tack coat distribution
Determination of Usable Residual Asphalt Binder in RAP

- Characterization of the amount of binder contribution from RAP materials during the mixing process
- **Outcome:** Validation of current mix design procedure and impact of various levels of RAP on HMA design and performance
- **Status:** Final report is being reviewed.
Research Approach

- Binder and aggregate recovery using Rotovapor method
- Prepare mixes using typical RAP as well as recovered materials
- Residual binder evaluation
- Impact of RAP on mixes:
  - Content: various levels (0, 20, and 40%)
  - Performance: complex modulus, moisture sensitivity, and fracture energy
  - Interaction Mechanism: Electron microscopy
Preliminary Research Outcome

- RAP binder (for mixes up to 40% RAP) is efficiently working in the mixes.
- Current mix design procedure has been validated.
- Complex modulus results showed an increase in mix stiffness with RAP increase.
- Moisture susceptibility may be reduced when RAP is used.
- Preliminary testing suggests an increase in low temperature cracking potential with increasing RAP.
Impact of High RAP Content on Pavement Structural Performance

- Demonstrate impact of high RAP percentages (20+ to 40+%) on HMA structural and performance characteristics ($E^*$, fatigue, low temperature fracture, rutting, and moisture susceptibility)
- Prepare mix designs at a variety of % RAP, binder grade (PG 64-22, PG 58-22, and PG 58-28); perform structural tests; conduct performance tests
- **Outcome:** impact of high RAP % on HMA performance (limitation); impact of grade bumping on performance properties
- **Status:** To be started
Cost-Effectiveness and Performance of Overlay Systems in Illinois

- Evaluate the effectiveness of interlayer systems in controlling reflective cracking.
- **Outcome:** Develop an interlayer system assessment system and quantify the interlayer system effectiveness.

**Field Crack Survey**
- Pavement Distress Survey
- Joint/Patch Detection
- Reflective Crack Identification

**Forensic Investigation**
- Reflective Crack Pattern
- Interface Failure Phenomenon
- Material Properties

**Life-Cycle Cost Analysis**
- Cost-Effectiveness Agency and User Cost
- Interlayer Systems Decision
Research Outcome

**Performance of Interlayer Systems**

Evaluation of Material Properties of HMA

Development of Interlayer System Application Map

Development of Interlayer System Decision Program

CIND

**COST-EFFECTIVE INTERLAYER SYSTEM DECISION PROGRAM**

Version 1.0

Illinois Department of Transportation

Click to Start
Preliminary Findings

- The cost-benefit of interlayer systems depend on field performance, material cost, construction time, and joint spacing (based on quantitative assessment of various types of reflective cracking interlayer systems).

- System D (ISAC) outperformed the other investigated systems regardless of traffic volume, followed by system E (Sand mix). Area-wide System A (Non-woven fabric) had a marginal performance benefit.

- A simplified ESAL-\(T_L\) chart was developed to select the appropriate interlayer system to retard reflective cracking; a program (CIND) was developed for detailed and cost effectiveness analysis.

- Fracture energy of overlay and interlayer system materials was highly correlated with field performance.
Binder Testing and Analysis

- Analyze DSR data, G*, of typical IDOT binders to provide indications of expected HMA Dynamic Modulus (E*) values for use in pavement design.
- Construct G* Master Curves using rhea software, then predict E* Master Curves using Hirsch Model (bad low temp data).
Binder Testing and Analysis (Outcome)

- Predicted E* within PG64-22 grade was comparable to lab-measured E*. 
- Cannot assign E* differences based on grade differences nor within a grade. 
- Binder modulus is highly variable at pavement structural temperatures (70–90F); it is not indicated by grading temperature information.
Validation of Extended Live HMA Pavement Designs

- Verify structural analysis for multi-layered pavement structure; provide test data for dynamic modulus, E*, and fatigue for current IDOT mixes; validate the existence and magnitude of a fatigue endurance limit (FEL).

- Outcome: Verification of typical E* values for surface and binder mixtures; verification of improved typical fatigue algorithms for IDOT binder mixtures and FEL; examination of response and fatigue failure in thin sections; differences between field and lab

- Status: New fatigue equations for rubblization and full depth HMA designs (report on ICT website)
Performance of HMA Overlays in Illinois

- Assessed overall performance of overlaid pavement sections on two subsets of network pavement.

- **Outcome**: Effectiveness of SMART (Surface Maintenance at the Right Time) & of policy overlays for sections constructed from 1980-2001 vs. 2001-present.

- **Status**: Final report posted on ICT website in September ‘08.
Nondestructive Pavement Evaluation Using ILLI-PAVE Based ANN Models

- Developed advanced models based on ILLI-PAVE FE solutions for rapidly and more accurately back-calculating pavement layer properties from FWD data.

- **Outcome:** ANN-Pro and SoftSys software for computing pavement layer moduli & thicknesses.

- **Status:** Final report is available on ICT website.
Characterization of IL Aggregates for Subgrade Replacement & Subbase

- Characterizes strength, stiffness, and deformation behavior of various types IL commonly used aggregate.
- **Outcome:** Improved aggregate cover thickness predictions for subgrade replacement and subbase
- **Status:** Lab testing 80% completed; Final Report due in June 2009.
Expansive Characteristics of Recycled Materials Used as Pavement Base Materials

- Evaluated expansive properties of some RAP for use as pavement base.
- **Outcome:** Recommendations for RAP material expansion potentials compared to virgin steel slag aggregate.
- **Status:** Final report is currently under review; to be available end of 2008.
M-E Design, Implementation & Monitoring of Flexible Pavements

- Cooperate with IDOT to update, revise & justify full-depth HMA design procedure; review/revise HMA OL thickness design algorithm for rubblized PCCP; & provide technical support

- **Status:** In progress/ current emphasis on full depth HMA
Development of a Thin, Quiet, Long-Lasting, High Friction Surface Layer for Economical Use in Illinois

- Physical properties as well as cost-benefit of various newly developed surface mixtures will be measured and compared.
- **Outcome**: identify/develop a cost-effective mix for a new generation of surface layers (durable, high friction, and low noise).
- **Status**: In Progress.
Other Selected ICT Projects: Hot-Mix Asphalt

- Profile Equipment Verification
- Hot-Mix Asphalt Sampling
- Cold In-Place & Full-Depth Recycling with Asphalt Products
- Performance of HMA Overlays in Illinois
- Evaluation of Pavement Damage Due to New Tire Designs (Wide-Base Tires)
- Expansive Characteristics of Recycled Materials Used as Pavement Base Materials
- Characterization of IL Aggregates for Subgrade Replacement & Subbase
Nighttime Construction: Evaluating Lighting Glare

- Levels of glare and lighting performance of various lighting arrangements were analyzed and compared.
- **Outcome:** Recommendations for lighting arrangements that reduce and control glare at nighttime work zones.
- **Status:** Final report is available on ICT website.
Acknowledgements

The Illinois Center for Transportation (ICT) is an innovative partnership between the Illinois Department of Transportation (IDOT) and the University of Illinois at Urbana-Champaign (UIUC). FHWA support is greatly appreciated.