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<tr>
<td>Ken Agent</td>
<td>Research Engineer</td>
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<tr>
<td>Eric Green</td>
<td>Research Engineer</td>
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<tr>
<td>Adam Kirk</td>
<td>Research Engineer</td>
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<tr>
<td>Nithin Agarwal</td>
<td>Research Engineer</td>
</tr>
<tr>
<td>David Cain</td>
<td>Technical Analyst</td>
</tr>
<tr>
<td>Neil Tollner</td>
<td>Programmer/Analyst</td>
</tr>
<tr>
<td>Tony Fields</td>
<td>Research Analyst</td>
</tr>
<tr>
<td>Nick Stamatiadis</td>
<td>CE Professor</td>
</tr>
<tr>
<td>Mei Chen</td>
<td>CE Professor</td>
</tr>
<tr>
<td>Reg Souleyrette</td>
<td>CE Professor</td>
</tr>
<tr>
<td>5 Undergraduate Students</td>
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Program Topics

- Evaluation of Highway Safety Features
- Crash Data Analysis
- Evaluation of Traffic Control Devices
- Traffic Data Analysis
- Evaluation of Geometric Design Elements
- Traffic Modeling and Simulation
Traffic and Safety Research Activities

Strategic Highway Safety Plan

Toward ZERO Deaths

Kentucky Strategic Highway Safety Plan 2011—2014
Areas of Research

STRATEGIC HIGHWAY SAFETY PLAN

Governor’s Representative for Highway Safety
Kentucky Transportation Cabinet Secretary

Governor’s Executive Committee on
Highway Safety

Kentucky Transportation Cabinet
Office of Highway Safety

Traffic Records (KTRAC)

Legislative Liaison

Strategic Highway Safety Plan

Aggressive Driving
Commercial Vehicle Safety
Distracted Driving
Impaired Driving
Intersections
Motorcycles
Roadway Departure
Young Drivers
Incident Management
Occupant Protection
Traffic and Safety Research Activities

TECHNICAL SUPPORT FOR HIGHWAY SAFETY IMPROVEMENT PROGRAM
Areas of Research

HIGHWAY SAFETY IMPROVEMENT PROGRAM

• HSIP is a “Core FHWA Program” to Reduce Fatalities and Serious Injuries

• $40+ Million Provided to Kentucky for Current FY

• KTC Provides Data Analysis to Support Prioritization

• Application of HSM Methodologies
Areas of Research

PRIMARY ACCOMPLISHMENTS

• Identification of Sites and Evaluation of Rumble Strips/Stripes
• Database Development
• Intersection Improvement Plan
• High-Friction Surface Evaluation
• Identification of Sites and Evaluation of Cable Barriers
• Preparation of Three Annual Reports
Areas of Research

CENTERLINE RUMBLE STRIPES AND MILLED SHOULDER RUMBLE STRIPS

KY 163, Monroe County
Figure A-13. Rumble Stripe (Dry, Nighttime Condition) (Garrard County).
Figure A-14. Rumble Stripe (Wet, Nighttime Condition) (Garrard County).
Safety Belt Usage Rates (US vs. Kentucky)
## Trend In Motorcycle Helmet Usage (Percent Using Helmet)

<table>
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<th>YEAR</th>
<th>PERCENT USAGE</th>
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<td>1999</td>
<td>65</td>
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<tr>
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</tr>
<tr>
<td>2012</td>
<td>53</td>
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iOS App for Pavement Rating

Make sure data is downloaded before going into field.

Start inspections
RT UNIQUE 057-US-0027X-000
Evaluation Date 07-JUL-10
Fiscal Year 2014
Route ID US0027X
County Number 057
Lane Direction *
Lane Number *
Beginning Milepoint 2.18
Ending Milepoint 3.89
Length of Section 1.71
Project ID FD05-057-027X-002-004
From Description KY 39/KY 29
To Description US 27
Proposed By PMB
Example SPF

CRASHES PER YEAR

![Graph showing the relationship between Crashes per Year and AADT. The graph indicates an upward trend as AADT increases.]
Delta

Crash Frequency

- Observed Number
- Expected Number Using EB
- Predicted Number from SPF

AADT

SPF
Delta Map

Eligible Sections by Delta Value

Deltas
-5.8 -2.1
-2.1 -0.3
-0.3 -1.3
1.3 -3.5
3.5 -7.8
Versailles Road Multimodal Corridor Study

- Travel Survey
- Alternative Analysis
- Crash Analysis
- Recommended Countermeasures

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![Map of Versailles Road Multimodal Corridor](image1.png)

![Pothole Image](image2.png)
Technical Training

- Signal Technician
- Signal Timing
- Basic Geometric Design Training
- Advanced Geometric Design Training (Intersections)
- Survey Training
- Policy Training for KYTC Prequalification
Pavement Materials and Geotech

Clark Graves – Program Manager
Brad Rister – Research Engineer
Charlie Sun – Research Engineer
David Hunsucker – Research Engineer
Kean Ashurst – Research Engineer
David Allen – Research Engineer (part-time)
Tim Scully – Research Investigator
Dan Eaton – Engineering Technician
Jamie Creech – Engineering Technician
Tim Jones – Engineering Technician
Levi McIntosh – Engineering Technician
Richard Reitenour – Engineering Technician (part-time)
Joe Whelan – Graduate Student

6 Research Engineers
1 Research Investigator
5 Engineering Techs
1 Graduate Student
Areas of Research

- Pavement Design and Construction
- Forensic Studies
- Materials
- Highway Drainage
- Traffic Loading
- Structural Instrumentation Testing
- Geotechnical Evaluations
- Utilization of LiDAR
- Evaluation of High Friction Surfaces
- Bridge Instrumentation
- Ground Penetrating Radar (GPR) Evaluations
Where Are We Working?

- Asphalt Field Projects
- Warranty Evaluations
- Bridge/Culvert Evaluation Projects
- Forensic Evaluations
- Longitudinal Joint Study
- Lidar Projects
Project Highlights

• Forensic Evaluations
• High Friction Surface Materials
• Culvert Inspection and Evaluation
• Use of LiDAR
Forensic Evaluations

• Subsurface Pavement Evaluations, Louisville Southern Indiana Ohio River Bridges (LSIORB)
• Determine in-situ conditions for use by design-build teams
• Ground Penetrating Radar, Falling Weight Deflectometer, Pavement coring
High Friction Surface (HFS)
Friction Results

All Sites Plotted by Age and $\mu$ Value

- HFS Avg $\mu$ RWP
- HFS Avg $\mu$ CWP
- HFS Avg $\mu$ LWP
- AC Avg $\mu$ RWP
- AC Avg $\mu$ CWP
- AC Avg $\mu$ LWP

Kentucky Transportation Center
Pipe Inspection Certification Program

• Purpose is to ensure consistent results among contractors
• Consistent reporting format
• Set up a “test track” with flexible and rigid pipe
• Distress pipe with in situ like conditions
• Contractor is to come in and video and laser inspect pipe and submit report
• KTC to determine compliance with KYTC specs
Applications of LiDAR

- Monitor bridge piers (stationary LiDAR)
- Check bridge clearance heights (mobile LiDAR)
- Determination of existing pavement profile (mobile LiDAR)
Data example from Pier A scanned on:

12/11/2012

12/19/2012

1/9/2013
Summary

• Develop or apply emerging technologies/applications
• Evaluation of innovative materials and technologies
• Provide savings for design, construction, and maintenance projects
• Help improve the industry
KTC Program Name: Structures
Program Manager: I.E. Harik

• Current Employees
  – Full-Time: Dr. A. Peiris
  – Ph.D. Student: Mr. A. Jawdhari
  – U.G. Student: Mr. B. Benifield
  – U.G. Student: Mr. T. Blair
  – U.G. Student: Mr. M. Crossley
Program Topics

Field Testing and Modeling

The Maysville Bridge
The Clear Creek Bridge demonstration project: a photo essay

Visitors to Kentucky’s Daniel Boone National Forest now have a high-tech link to a major hiking trail. A 60-ft. long composite bridge provides access from the Clear Creek Furnace picnic area to the Shellabee Trace National Recreation Trail. Installed on November 14, 1996, the bridge’s main load-carrying members are 24-in.-deep pultruded composite I-beams (glass-fiber reinforced vinyl ester with carbon fiber in the flanges to increase stiffness). "As with most composites, stiffness did not control the design," says Iasma Hark, professor at the University of Kentucky’s Department of Civil Engineering. "In fact, the beam without the carbon would have been several times stronger than what was required. Limiting deflection of the bridge under normal foot traffic was the characteristic that controlled the design." Adding carbon fibers to the section more than doubled the stiffness of the beam (CDA Fall '96, 7). But doubling the stiffness of the beam was not enough to allow...
The residents of the community of River in Johnson County, Kentucky are the beneficiaries of the longest plastic bridge deck in the world. (The second longest is in Scotland). The deck of the 420-foot footbridge, over the Lovers Fork of the Big Sandy River, is made of FRP composite materials.

Dr. Issam Harik, professor of civil engineering, read of the plight of the residents of River in 1994 in an article in the Lexington Herald-Leader. An existing wood footbridge, built in the 1930s, had fallen into disrepair. "It looked like something Indiana Jones would have to cross," said Freddie Goble, project manager for the Big Sandy Area Development District.

The wooden bridge deck had numerous holes and all four primary cables were rusted, one to the point of having broken. Many residents continued to use the old bridge, however, saving themselves an hour round-trip by car. Without the footbridge, residents would be forced to drive 15 miles up the river to an automobile bridge and then 7 miles back down to the other side of the footbridge. On the other side lies the local post office, River United Baptist Church, and friends and family.

Dr. Harik is considered a proponent authority on the use of composite materials in structures. He saw this project as a good fit for composite materials. Harik and his research team began the project independently of any government agency. Brad Robinson and Michael Whitney (graduate students working with Dr. Harik at the time) worked on the design and analysis of an all FRP bridge as a possible replacement of the River bridge as a project in a graduate course. Once their design and analysis was completed, Harik contacted the Kentucky Transportation Cabinet (KyTC) and the Johnson County Judge who were already working on securing funds to replace or retrofit the bridge.

It was determined that the entire structure was in such disrepair it would all need replacing. The cost of this extensive replacement project far exceeded the funds which were originally allocated the initial plan, which involved repair of non structural portions of the bridge.

Over the next three years, the $527,560 needed to complete the bridge was procured from the Federal Highway Administration, the Kentucky Transportation Cabinet and from R. B. Preston, a Johnson County native and private citizen. Once funding was secured, construction began in November 1998 with completion in April 1999.

("Plastic Bridge" continued on p. 42)
Glass FRP Rebars

Second Bridge in the US With GFRP Bars

Roger’s Creek Deck, Kentucky - 1997
Carbon FRP Rebars

First Bridge in the US
With CFRP Bars

Clark County Bridge, Kentucky - 2002
Aluminum Bridge Deck

KY 974 Bridge Over Howard Creek Clark County, KY

Bridge Ready for Traffic

After 2 Hours

07/20/2006
Bridge on KY 3297 over Little Sandy River
Carter County, Kentucky

Shear Cracks in P/C Box Beams
CFRP Fabric on Inside Faces of the Beams Was Not Painted to Match Concrete Color
I-65 in Louisville

PIER 6 at Main & Hancock ST

PIER 4 at Jefferson & Preston ST

PIER I-65 over Muhammad Ali Blvd.

PC spans between Broadway & Chestnut

PC spans between Jacob & Gray ST
First Application of Triaxial Fabric on Bridges
Second Bridge in the World
With UHM CFRP Laminates

KY 32 Bridge
Scott County, KY
CatStrong
CFRP Rod Panels
Developed at U. of KY
**CRP-195 vs. Steel**

- **CatStrong CRP-195**
  - $t_c = 0.156$ in
  - $W_C = 0.43$ lb/ft

- **A36 Steel**
  - $t_s = 0.28$ in
  - $W_S = 11.45$ lb/ft $\approx 26 W_C$

**Ultimate Load = 195 kip**
CRP-195 vs. CFRP Fabric

$W_C = 0.43 \text{ lb/ft (without epoxy)}$

$t_C = 0.156 \text{ in}$

$W_F = 0.125 \text{ lb/ft} \approx 0.3 \ W_{CRP}$ (without epoxy)

$t_F = 0.16 \text{ in (with epoxy)}$

Ultimate Load = 195 kip
Repair of the KY218 Bridge Over Blue Springs Creek, Hart County, KY

First Application of CatSrong CRP80 (week of September 19, 2011)

Step 1: Application of resin on concrete girder

Step 2: Application of CRP80 on resin

Step 3: Application of resin coat on CRP80

Girder strengthened with CRP80
Sunnyside-Gotts Road over I-65
CatStrong CRP 195 Application
KY 81 Bridge, McLean County, KY
Beam After Repair (9/18/12)

(Repaired beam is stronger than the original beam when the bridge was first opened to traffic)
Results that have benefited KYTC

**Original Solution:** Replace the Superstructure  
- Cost: ~ $600,000  
- Close Bridge to Traffic

**Alternate Solution:** CFRP Fabric  
- Cost: $105,000  
- Bridge Remains Open to Traffic

Bridge on KY 3297 over Little Sandy River  
Carter County, Kentucky
Results that have benefited KYTC

Repair With Carbon FRP by District Personnel
Intelligent Transportation Systems
Jennifer Walton

• Current Employees
  – Andrew Martin, Research Associate
  – Mark Spellman, Research Associate
  – Jerry Kissick, Research Engineer
  – Mark Bell, Research Associate/Advisor
  – Valerie Keathley, PhD Candidate
  – Daniel Schwendeman, Undergraduate Student
  – Zack Palumbo, Undergraduate Student
Program Topics

• Policy and Tax Issues Related to the Motor Carrier Industry
Program Topics

- Support of Kentucky’s Commercial Vehicle Information Systems and Networks (CVISN) & Performance Registration Information Systems Management (PRISM) Programs
Program Topics

• Commercial Vehicle Electronic Screening
Program Topics

• Traffic Incident Management

Pictures provided by Code 3 Images
Program Topics

- ITS Planning and Architecture Development
Commercial Vehicle Related – Results

- London NB Weigh Station Ramp
Incident Management Related - Results

- Highway Crash Site Management Workshop and Handbook
- Emergency Traffic Control Workshop
Bridge Preservation Program
Overview
Sudhir Palle, P.E.

Program Mission:
Conduct research and investigations on technologies to extend the lives of bridges

Program Composition:
Five full-time and two temporary employees located at the Whalen Building
Bridge Preservation Program Facilities

9/20/04 9:50am

9/22/04 2:20pm
Monitoring Experimental KYTC Bridge Projects
Nondestructive Evaluation of Bridges
Addressing Major Bridge Concerns
Construction Engineering & Project Management

– Program Manager
  • Tim Taylor, P.E., Ph.D.

– Research Engineer
  • Roy Sturgill, P.E.
The section focuses on integrating construction knowledge into *project planning and design* in order to improve a project’s cost, schedule, quality, and safety performance.

- Cost Estimating
- Scheduling
- Project Delivery
- Contract Administration
- Quality Control/Assurance
- Safety
High Value Project for Highway Design

• Updating the Kentucky Contract Time Determination System
  – Different methods per project type & contract schedule goals
  – Existing system out-of-date and had a 233% mean variance in analysis (predominant model across U.S.)
  – Created a new regression method tool for contract time estimation (52% mean variance) while also revising existing system for
<table>
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<th>Item No</th>
<th>Activity</th>
<th>Unit</th>
<th>Input Design Quantity</th>
<th>Default Production Rate, Unit/Day</th>
<th>Default Activity Duration, Days</th>
<th>Production Rate Override, Unit/Day</th>
<th>Activity Duration Override, Days</th>
<th>Calculated Activity Duration, Days</th>
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New Method (52% Mean Variance*)

- Two Methods for Determining Contract Time
  - Projects >$1 million
    - 5 Project Types
    - Regression Driven Spreadsheets
  - Projects <$1 million
    - Develop full schedule or use seasons

*This was the overall average for the five types; 4 of the 5 models were less than 40%
## Large Project Example

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<td>Engineers Estimate (2005 Dollars)</td>
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<td>DirtWork_Roadway Excv. (CY)</td>
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<tr>
<td></td>
<td>Storm Sewer (LF)</td>
<td>1100</td>
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This Calculation is for Limited Access Only!
Project Status

• Currently Available
• Implementation Guide is Under Review
• Additional Guidance/Training is in Development
  – Instructional Videos
  – Possible Onsite Visits