

ANNUAL REPORT - FY2022



KENTUCKY TRANSPORTATION CENTER

ADVANCING TRANSPORTATION THROUGH INNOVATIVE RESEARCH AND EDUCATION





KENTUCKY TRANSPORTATION CENTER

ADVANCING TRANSPORTATION THROUGH
INNOVATIVE RESEARCH AND EDUCATION

OUR VISION:

KTC addresses the dynamic and emerging challenges faced by our stakeholders through research and education that enhances the safety, efficiency, and sustainability of transportation systems.

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OPENING REMARKS

LETTER FROM THE DIRECTOR

DOUG KREIS

Throughout KTC's history our annual reports have focused on the previous calendar year. This report marks a change in that tradition. Moving forward, our annual reports will focus exclusively on the events, achievements, and budgetary information of the previous fiscal year. Because the Center's rhythms are tied to the fiscal year calendar — which runs from July 1 to June 30 — shifting the time period covered by our annual reports will give our clients and partners a clearer picture of KTC's research accomplishments over the previous year and how our research and technology transfer activities align with the Center's budget. Because of this transition, some content in this document overlaps with material found in the calendar year 2021 annual report released earlier this year.

During the first half of FY 2022, KTC's program managers and leadership worked collectively to develop a strategic plan that will guide our activities over the next 10 years. After internal deliberations and some last-minute polishing, we finalized the plan during Q3. We are very proud of this document. It succinctly articulates who we are as a Center and what we hope to build in the coming years. Our mission is simple: Advance transportation through innovative research and education. By helping our clients, partners, and stakeholders respond to emerging challenges through high-quality research products and technology transfer, we are doing our part to help Kentucky and the U.S. develop safer, more efficient, and sustainable transportation systems. The strategic plan — which can be [downloaded from our website](#) — also discusses long-term goals and the strategies KTC will implement to achieve them.



The scope and magnitude of KTC's research output during FY 2022 was unprecedented. Our researchers finalized and published 23 new reports, which can be [downloaded from UKnowledge](#). In addition, researchers submitted approximately 15 more to the Kentucky Transportation Cabinet (KYTC) for review. While research publications play a critical role in equipping practitioners with new concepts and ideas, equally important are the training and events presented by KTC's Technology Transfer (T2) program. Over 8,000 participants took part in T2's 300+ workshops and courses, acquiring the knowledge, skills, and abilities they need to excel in the transportation industry and better serve the public. Throughout the year our experts remained on call to help KYTC diagnose the condition of pavements, structures, and other key assets, and provided rapid research assistance on topics ranging from design methods and contracting procedures to Kentucky's readiness for electric vehicles. Our work on rapid infrastructure assessment and quick turnaround projects do not always culminate in a formal report but nonetheless help the Cabinet find answers to questions that must be addressed immediately. Across all activities, KTC brought in over \$10 million in funding in FY 2022. With the effects of the Bipartisan Infrastructure Law beginning to take effect, we anticipate that FY 2023 will be even busier. KTC is prepared to help the Cabinet deliver the influx of new projects that are on the docket.

Many other initiatives are on the horizon for FY 2023, including the public launch of Highway Knowledge Portal (HKP). This website will provide KYTC, the consultant community, and contractors access to materials and information that will help them to deliver projects more efficiently. The amount of content on HKP is poised to grow rapidly, with over 20 new articles in the pipeline. KTC will also wrap up its own website redesign in the first quarter of the new fiscal year. Pairing this upgrade with our refreshed logo will strengthen the Center's branding and improve our public visibility. With another new batch of State Planning and Research (SPR) projects just around the corner and a multi-year infrastructure assessment project just getting off the ground, I am confident that KTC's research and technology transfer efforts will achieve new heights in the next fiscal year.

ABOUT KTC

For over 80 years, the KTC has excelled at delivering practical solutions to critical transportation problems, stellar technology transfer, and unparalleled customer service. Founded as a small materials research division in 1941, today KTC has a multidisciplinary orientation, allowing researchers to touch on every dimension of multimodal transportation. KTC addresses dynamic and emerging challenges faced by our clients through research and education that enhances the safety, efficiency, and sustainability of transportation systems. Our research products and trainings help us deliver on our mission of advancing transportation through innovative research and education.

We have established a strong partnership with the KYTC while building relationships with other state transportation agencies, private firms, and leading transportation organizations. Spread across 13 program areas and located in the University of Kentucky's College of Engineering, the Center's staff collaborates with expert faculty and conducts research in labs equipped with the most advanced technologies. As KTC continues to grow, we will remain committed to delivering transformative solutions that address the urgent problems facing local, regional, state, and national transportation systems.

KTC HISTORY

1941 ▶

The Kentucky Highway Department established a Division of Research located on the University of Kentucky's campus. The initial focus was primarily on materials research.

1979 ▶

UK's Board of Trustees created the Kentucky Transportation Center.

1981 ▶

UK and the KYTC finalized an agreement for UK to assume the agency's research function.

1988 ▶

KTC combined its research and technology transfer functions.

1993 ▶

KTC managed the regional Advantage I-75 Operational Test Project.

1995 ▶

KTC and the Department of Civil Engineering moved into a new building, which was later dedicated to Oliver H. Raymond, a UK College of Engineering graduate and benefactor.

2000 ▶

KTC led the development of Context Sensitive Design training and conducted workshops across the US.

2007 ▶

KTC received federal grants to work on Fedtrak and Section 1554 to address hazardous materials logistics and security in the US.

2011 ▶

KTC contributed to the evaluation and rehabilitation of the I-64 Sherman Minton Bridge.

2013 ▶

KTC partnered with KYTC and FHWA to implement traffic incident management training to improve the safety and effectiveness of first responders across Kentucky.

2014 ▶

KYTC named its first full-time Innovation Engineer to oversee all Cabinet research activities.

2015 ▶

Project Manager's Boot Camp and Boot Camp Xpress training were first offered to KYTC and consultant project managers.

2018 ▶

KTC and KYTC established a multiyear partnership to develop the Highway Knowledge Portal, a web-based reference for the Cabinet's technical guidance and policies.

2020 ▶

KTC rapidly adapted research and business practices to a hybrid work environment, including a successful movement to online training.

2021 ▶

Highway Knowledge Portal went live. It is accessible to any KYTC employee from any project site.

2022

KYTC awarded KTC a six-year contract for pavement forensics and pavement design technical assistance, allowing for the purchase of new technology and equipment that diagnoses structural issues.



STRATEGIC PLAN

MISSION

Advancing Transportation Through Innovative Research and Education

VISION

KTC addresses the dynamic and emerging challenges faced by our stakeholders through research and education that enhances the safety, efficiency, and sustainability of transportation systems.

VALUES

RELATIONSHIPS

Enduring relationships with the Kentucky Transportation Cabinet (KYTC), U.S. Department of Transportation, local agencies and governments, research and industry organizations, and other clients make our work possible. Equally instrumental are strong relationships with colleagues and collaborators in departments and colleges across the University of Kentucky. Each day, through research and technology transfer activities, we strive to expand and strengthen these partnerships.

INNOVATIVE RESEARCH SOLUTIONS

Our high-value research and technology transfer are transformative, responsive, and practical. KTC is helping clients reimagine and reshape their transportation futures by delivering cost-conscious solutions that can be efficiently implemented and integrated into operations.

DEDICATION & INTEGRITY

Our dedicated team adheres to the highest professional and ethical standards. We are fully invested in the promise of knowledge and expertise to create safer, more efficient, and more resilient transportation systems.

OUR PEOPLE

Researchers, technology transfer professionals, and administrative personnel are the engine that drives KTC. Our culture is built on investing in the Center's employees so they can acquire the knowledge, skills, and proficiencies needed to flourish professionally and deliver the service our clients expect.

DIVERSITY & TEAMWORK

Diversity in people. Diversity in thought. Not only does the Center prioritize recruiting women and members of underrepresented groups, we embrace a holistic approach to research and instruction that dismantles disciplinary silos. Building an inclusive environment that facilitates cross-disciplinary work strengthens the critical faculties of all employees and bolsters our capacity to collaborate with external stakeholders.

FAST DELIVERY OF HIGH-QUALITY PRODUCTS

Our team is committed to delivering research and training products of unsurpassed quality to KTC's clients quickly and efficiently. No deadline is too short. No request is too arduous. Regardless of the timeline, we collaborate with our clients through respectful engagement, work to understand their needs, and furnish solutions on time and on budget.

STRATEGIES

FORGE LONG-TERM MULTIDISCIPLINARY RESEARCH PARTNERSHIPS

KTC enjoys thriving partnerships with KYTC and its other clients. Along with nurturing and building these relationships, our team will work aggressively to increase its portfolio of research and technology transfer services, pursue new clients and funding, and explore opportunities for partnerships with stakeholders throughout the transportation industry. KTC enjoys thriving partnerships with KYTC and its other clients. Along with nurturing and building these relationships, our team will work aggressively to increase its portfolio of research and technology transfer services, pursue new clients and funding, and explore opportunities for partnerships with stakeholders throughout the transportation industry.

STRATEGIES

- Engage prospective clients the Center has not traditionally worked with
- Grow research portfolio by engaging all KYTC departments and soliciting agencywide input for the SPR process
- Increase partnerships and expand dialogue with colleges and departments at the University of Kentucky
- Invite young KYTC staffers to participate in the research process and serve on study advisory committees

DELIVER INNOVATIVE PRODUCTS THAT TRANSCEND EXPECTATIONS

We have an exemplary track record of delivering outstanding and timely research and technology transfer services. Moving forward, KTC will continuously improve the efficiency and quality of research and instruction while becoming an industry leader in delivering practical yet innovative solutions.

STRATEGIES

- Complete projects on time and on budget
- Measure and track client satisfaction
- Pursue new opportunities for innovative applied research
- Explore non-traditional research delivery methods (e.g., video, apps, social media)
- Encourage and finance continuing education and professional development

STRENGTHEN KNOWLEDGE TRANSFER & RESEARCH IMPLEMENTATION

Implementation is how knowledge and research make a difference. Our team excels at developing implementation strategies and communicating findings to stakeholders and partners. The Center will deepen its focus in this area by helping clients accelerate implementation and measuring the real-world impacts of its activities.

STRATEGIES

- Refine and continue tracking research implementation metrics
- Hold outreach events for new and existing clients to share research findings and implementation efforts
- Create a multi-platform approach to disseminate project results
- Collaborate with KYTC marketing and public relations staff and other clients to facilitate implementation

ENHANCE KTC'S VISIBILITY ON THE NATIONAL STAGE

Within Kentucky and at the regional level KTC is acknowledged as a leader in applied transportation research and technology transfer. Enlarging the Center's footprint on the national stage demands that we tap into new funding sources. Gaining national visibility requires our team members to bolster their participation in and contribute to national organizations (e.g., AASHTO, TRB) while continuously growing research and instructional capabilities in response to emerging client needs.

STRATEGIES

- Increase presence on committees and sub-committees of organizations
- Partner with other universities to pursue UTCs, NCHRP projects, and new external clients
- Recruit high-profile researchers and technology transfer specialists
- Market products to showcase their innovation and wide ranging applications

GROW AND RETAIN A DIVERSE TEAM

Achieving national prominence requires the development of an ambitious staffing plan and a commitment to building an open, respectful work environment that fosters diversity and multidisciplinary collaborations. We must leverage creative strategies and provide incentives (e.g., hybrid and flexible work arrangements) to attract and permanently retain staff. With competition for talented professionals growing fiercer by the day, our goal is to make KTC a place where people want to build meaningful, long-lasting careers.

STRATEGIES

- Increase KTC's visibility on UK's campus and in Kentucky's communities
- Develop recruitment methods and outreach strategies that successfully attract diverse professionals
- Work across campus to deepen engagement with underrepresented groups
- Create programs and financial incentives (e.g., scholarships, internships) to target and recruit students interested in transportation careers

FY 22 KTC ADVISORY BOARD

On April 27, 2022, KTC had the good fortune of holding our first in-person Advisory Board meeting since the onset of the COVID-19 pandemic in early 2020. Jim Gray, Secretary of KYTC, was on hand and delivered opening remarks that touched on the value of KTC's research contributions, the future of the state's transportation network, and how the Center can help the Cabinet fulfill its mission. James Ballinger, the State Highway Engineer, also spoke to attendees and highlighted ways in which the Center's work has been incorporated into the Cabinet's business operations. Representatives from each KTC program area presented updates on recently completed and ongoing research projects. Our next Advisory Board meeting is scheduled for November 2022.

CURRENT BOARD MEMBERS

JIM GRAY ► SECRETARY, KENTUCKY TRANSPORTATION CABINET, CHAIRPERSON

JAMES BALLINGER ► STATE HIGHWAY ENGINEER, KENTUCKY TRANSPORTATION CABINET

RUDY BUCHHEIT ► DEAN, COLLEGE OF ENGINEERING, UNIVERSITY OF KENTUCKY

ALEX BARNETT ► HARRISON COUNTY JUDGE/EXECUTIVE, KENTUCKY ASSOCIATION OF COUNTIES

PAMELA SMITH-WRIGHT ► MEMBER, KENTUCKY LEAGUE OF CITIES

CASEY ELLIS ► OWEN COUNTY JUDGE/EXECUTIVE, KENTUCKY COUNTY JUDGES ASSOCIATION

RANDALL WEDDLE ► LONDON, AT-LARGE MEMBER

MIKE LAW ► BOWLING GREEN, AT-LARGE MEMBER

JOHN DOUGHERTY ► LOUISVILLE PAINTING AND CONSTRUCTION, AT-LARGE MEMBER



PROGRAM AREAS

BRIDGE PRESERVATION

With transportation agencies lacking the funding to replace aging bridges, researchers in this program examine techniques and materials used to repair, reinforce, and preserve them. Key research topics include the effectiveness of protective coatings for concrete and steel, spot painting techniques, remediating chloride damage on steel bridges, the use of nondestructive technologies to inspect bridges, and bridge maintenance strategies.

CONSTRUCTION ENGINEERING AND PROJECT MANAGEMENT

The mission of this program is to improve the development and delivery of infrastructure projects, with a focus on safety, cost, schedule, and quality. Researchers have collaborated extensively with KYTC on improving construction inspection, updating construction guidance, and implementing aerial imagery that facilitates project delivery. The program has gained national prominence through projects undertaken as part of the National Cooperative Highway Research Program (NCHRP), including research on construction staffing issues and optimizing utility coordination processes.

EDUCATION, PLANNING, AND DECISION ANALYTICS

Researchers examine methods to strengthen the planning processes used by local, state, and federal transportation agencies. They address issues pertaining to highway and railroad operations and infrastructure, traffic monitoring and modeling, safety planning, and asset management. Researchers collaborated with KYTC to develop the most recent Kentucky Strategic Highway Safety Plan and investigated how congestion performance measures can inform the allocation of highway project funds for the Strategic Highway Investment Formula for Tomorrow (SHIFT).

INTELLIGENT TRANSPORTATION SYSTEMS

The ITS program determines possible uses for a broad range of advanced information and communications technologies, with the goal of improving the efficiency and safety of Kentucky's roadways. The program has enjoyed national prominence for more than 25 years due to its role in the Advantage I-75 Mainline Automated Clearance System for commercial vehicles. Currently, researchers are helping stakeholders modernize the International Registration Plan (IRP) clearinghouse.

MARKETING, MEDIA, AND TECHNICAL REVIEW

The group assists all program areas with publishing high-quality work that showcases KTC's capabilities to its clients and partners. Within KTC, it provides staff with logo development, graphic design, video production, photography, and report review and distribution, as well as posters, brochures, and booklets. The team often assists KYTC with publication services, most recently helping the agency develop and promote its strategic plan.

PROGRAM AREAS

OCCUPATIONAL SAFETY AND HEALTH

This program seeks to understand and track the factors that affect safety with the goal of measuring what is most valued: the safety, health, and well-being of KYTC employees. With funding from FHWA, KYTC, and NCHRP, the program has performed research on safety metrics, safety culture, and safety management systems. The program has several projects in progress: Specialized Safety Training and Tracking for KYTC Construction and Maintenance Personnel, Evaluating the Use of a Near Miss Reporting Program to Enhance Employee Safety Performance, and Practices to Motivate Safe Behaviors with Highway Construction and Maintenance Crews.

PAVEMENTS, MATERIALS, GEOTECHNOLOGY, AND INFRASTRUCTURE ASSESSMENT

This program focuses on improving the durability, resiliency, and service lives of roadways, highways, and bridges. Researchers use non-destructive technologies such as drone inspection and ground-penetrating radar (GPR) to diagnose pavement and structure issues and detect changes in bridge decks and tunnels. They are currently developing a pavement preservation process and investigating how Lidar can be used to facilitate highway resurfacing projects and determine bridge clearance heights along busy roadways.

POLICY, FINANCE, AND ECONOMICS

Researchers work with state, local, and federal agencies to understand the economic implications of policy proposals and emerging technologies, conduct financial and cost-benefit analysis, and examine legislative initiatives. Projects are often performed in conjunction with other program areas, such as the KYTC maintenance survey, defining core technical competencies required for Cabinet job roles, and developing training curricula for five KYTC subject-matter areas.

PROJECT DEVELOPMENT

Project Development specializes in helping state transportation agencies improve project development workflows and preconstruction project management. The group presents a training course that teaches KYTC and consultant project managers how to manage the activities required to deliver a project on time and within budget. Recent projects have sought to streamline the delivery of complex highway projects, such as defining a project scoping process and applying context classifications to the design of Kentucky's roadways.

PROGRAM AREAS

SPECIAL PROJECTS AND INITIATIVES

This program regularly brings together the expertise of researchers from around the Center, offering a multidisciplinary focus on a range of complex transportation topics — from environmental sustainability to hazardous materials and supply chain security. Highway Knowledge Portal is one example of a cross-program, multi-year effort that is reimagining how KYTC guidance and policy are delivered to agency staff.

STRUCTURES

The program is dedicated to evaluating and monitoring bridges and other structures and strengthening new and existing structures with novel, high-performance materials. Researchers have developed the CatStrong family of products—lightweight carbon fiber reinforced polymer materials used to rapidly repair and extend the service lives of deficient bridges. Researchers recently developed a biaxial pre-cured hemp fiber wrap to apply to deteriorating timber piles, and are planning more experiments with plant-based resins.

TECHNOLOGY TRANSFER

Since 1979, T2 has been delivering training and technical assistance to Kentucky's roadway providers. The program is nationally recognized for its work with the FHWA, Traffic Incident Management, and the American Public Works Association. Annually, T2 presents over 300 trainings, conferences, and events, enabling transportation professionals to earn and maintain certifications. Because of expertise gained with online learning during the COVID-19 pandemic, the program is able to reach more professionals through hybrid learning.

TRAFFIC AND SAFETY

The group's primary focus is to reduce crash frequencies and severities. Researchers rely on geographic information systems (GIS) and fieldwork to develop best practices for advancing highway safety. They are key players in collecting and analyzing data for FHWA's Highway Safety Improvement Program and investigate a wide range of topics — from seatbelt usage rates and improving traffic signage to studying the effects of climate change and severe meteorological hazards on critical infrastructure.

FY 22 HIGHLIGHTS

Pavement Preservation

Innovative pavement rehabilitation, monitoring, and preservation methods are playing a more critical role in lengthening the service lives of roadways, bridges, and tunnels. KTC's Pavements, Materials, Geotechnology, and Infrastructure Assessment group has taken on many projects focused on selecting more appropriate pavement rehabilitation concepts through the use of a pavements forensic analysis process, collecting and utilizing more informative pavement placement temperature data during construction, and studying modifications to asphalt materials to increase pavement service life and reduce long-term maintenance costs. Projects highlighted below demonstrate how the group is exploring innovative pavement rehabilitation and monitoring. Many of these efforts are quick response studies that help the KYTC keep pace with the latest advances in pavement preservation.



Use of Non-Destructive Techniques to Identify Pavement Rehabilitation Concepts

Non-destructive techniques used for forensic analysis of pavement can help design engineers make informed decisions about how to design or rehabilitate pavement structures. Five key pieces of information are collected during forensic analysis:

- Existing pavement thickness
- Pavement distress or the amount of cracking and rutting
- Structural capacity of the existing pavement structure
- Amount of future traffic loading
- Depths of existing cracks and/or depths of delaminations

KYTC has three vans that travel throughout Kentucky each year evaluating pavement distress. They use scanning lasers to measure surface cracks and rutting depths.

KTC researchers gather additional data with the following mobile test equipment:

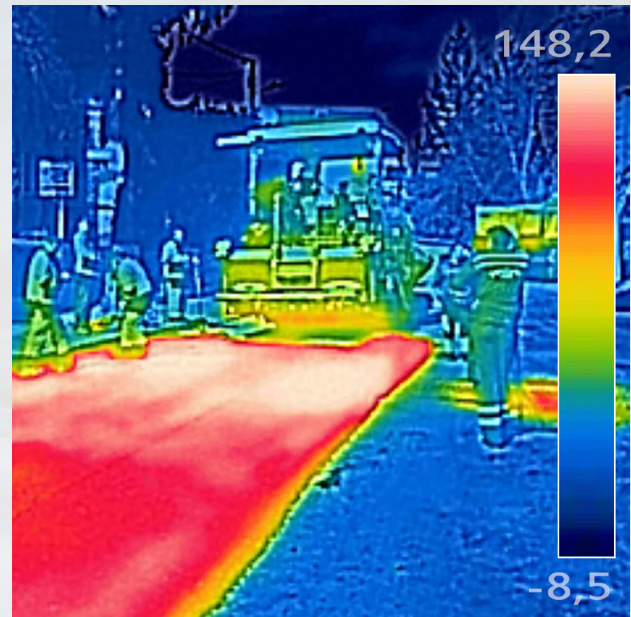
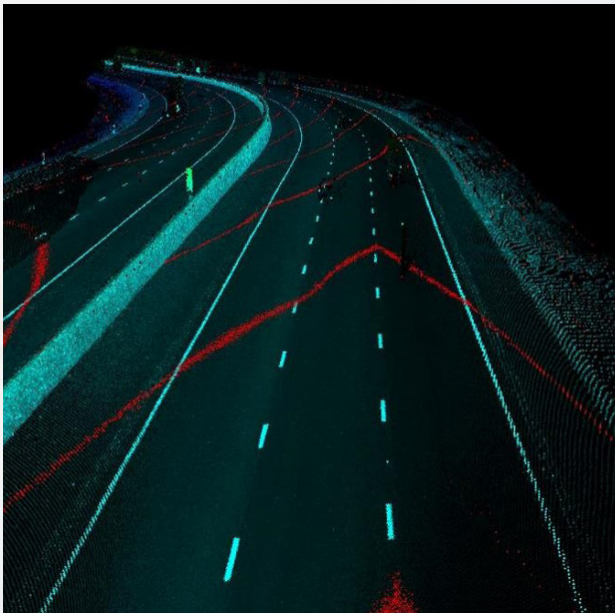
- Falling Weight Deflectometer (FWD) collects pavement stiffness/modulus along a length of pavement.
- Ground Penetrating Radar (GPR) maps subsurface pavement cross sections, measures the pavement layer thickness, and identifies voids and possible areas with low subgrade strength.
- Core Truck samples core data to verify depths of cracks, elevations of delaminations, and confirm the thickness values obtained by GPR.

KTC researchers work with the Cabinet to compile all pavement data and enter it into a modified version of the Mechanistic-Empirical Pavement Design Guide (MEPDG) so that a new pavement design can be generated.

FY 22 HIGHLIGHTS

Evaluation of Infrared Technology (Pave IR) and GPR for Uniformity Measurements During Asphalt Placement

Uniformity of hot-mix asphalt (HMA) materials is critical for the durability and performance of asphalt. Unfortunately, segregation and non-uniform density continue to cause construction-related problems across the US. Typically, this issue is due to non-uniform pavement placement temperatures, which can impact pavement service life. The SHRP2 program recently proposed the use of IR imaging for more reliable measurement of temperature uniformity across HMA layers to help contractors better plan delivery of HMA to job sites. Temperature measurements can be taken onsite, in real time, and viewed on a laptop computer as the paving operation is carried out. Additionally, this project is investigating the use of GPR to collect density measurements. If successful, density cores may be eliminated in the future.



Adding Additives to Asphalt Mixes

Aramid fibers are strong, heat-resistant synthetic fibers that can enhance the performance of asphalt mixes. Rosphalt is a super concentrated thermoplastic polymer additive that causes an asphalt mix to be more waterproof, improves wearability, and produces pavement that is more resistant to wheel rutting. The Pavements, Materials, Geotechnology, and Infrastructure Assessment group has implemented pilot projects in which these materials were added to pavement mixes to evaluate their long-term performance. Rosphalt has been used on two projects in Louisville, Kentucky: I-65 Riverside Expressway and the Lincoln Bridge. Aramid fiber materials were incorporated into asphalt mixtures laid on US 31 W in Louisville. All three projects are being monitored to gauge their long-term success.

FY 22 HIGHLIGHTS

Core Competencies

Core competencies are the foundational knowledge, skills, technologies, and abilities which must reside within an organization if it is to fulfill its stated mission while minimizing organizational risk. Many state transportation agencies (STAs) are faced with challenging funding environments and increased staff attrition. As a result, agencies often outsource projects to contractors and rely on alternative project delivery methods. Core competencies should not be outsourced to third parties, but without guidance, STA leadership are struggling to define core competencies and maintain the knowledge that is integral to organizational operations and critical functions.

Researchers at KTC are working with KYTC leadership in each division to define job functions and the specific technical competencies associated with each. Risk management plays an important role in identifying those technical competencies designated as core competencies. Determining required core competencies complements the specification of acceptable risks, while acceptable risks define required core competencies. As such, an important part of the brainstorming process is determining the level of risk imposed on an organization if a competency does not exist within it.

Identifying core competencies at KYTC is an ongoing process. Through facilitated sessions held over nearly two years, KTC researchers and KYTC leadership and subject-matter experts have collaborated to identify job roles within each Cabinet subject-matter area. They have catalogued the technical competencies for each job role and rated the associated risk of each. For each competency associated with a job role, risk is summarized using a risk matrix. The rating scale ranges from 1 to 5, with 1 being the lowest risk and 5 being the highest. Ratings have been calculated for each of the five risk factors that impact the technical competency:

- Quality
- Time
- Expense
- Programmatic Fiscal Impact
- Compliance

For example, KYTC's Division of Construction has five major job roles. Each requires several technical competencies. The risk matrix below is for the construction inspection competency within the Construction Section Office Personnel job role.

5	Safety
5	Quality
5	Time
4	Expense
5	Fiscal Impact
5	Compliance

FY 22 HIGHLIGHTS

The Core Competencies project will culminate in a guidebook for each major subject-matter area within KYTC that provides clearer definitions of job roles within Central Office and all highway districts. Subject-matter areas covered by the project include:

- Materials
- Permits
- Professional Services
- Railroad Coordination
- Right-of-Way
- Structural Design
- Traffic Operations
- Utility Coordination
- Construction
- Construction Procurement
- Environmental Analysis
- Geotechnical
- Highway Design
- Highway Safety
- Incident Management
- Maintenance

To foster organizational excellence and target recruitment and retention practices to the most critical job functions, KYTC leadership must decide which technical competencies are deemed Core Competencies. To ensure that oversight and decision-making skills remain in-house, Core Competencies must be maintained across the organization. Competency guidebooks will provide a resource for leadership to aid in decision making and risk management and serve as a reference for early career staff and personnel transitioning to new job roles.



FY 22 NEWS AND ACHIEVEMENTS

NEWS AROUND THE CENTER

- Traffic & Safety new hires: Emma Gregory and Nathaniel Swallom.
- Technology Transfer new hires: Gillian Herzberg, Bryan Sanders and Brittany Cloyd.
- Xu Zhang became a member of TRB's Highway Traffic Monitoring Standing Committee (ACP70).
- Erin Lammers completed her Masters in Civil Engineering (August 2021).
- The ITS group participated in the expansion/growth of Kentucky CDL Advisory Committee and Outreach Efforts .
- ITS Presentation given to Kentucky Trucking Association on CDL Compliance Issues (August 6, 2021).

AWARDS AND ACCOLADES

- Dr. Issam Harik (Structures Program) received the 2021-2022 University Research Professor Award.
- Technology Transfer's LTAP is celebrating its 40th Anniversary in 2022. T2 submitted a poster for the national competition.
- Each year, the National Local Technical Assistance Program Association (NLTAPA) conference provides an opportunity for Centers to highlight innovations or accomplishments with an annual poster competition. Kentucky used the 2022 conference theme "Looking Back, Moving Forward" as an opportunity to celebrate its 40th anniversary and showcase its incredible growth since the Technology Transfer (T2) Program's inception in 1983. Conference participants browsed the posters on display and voted on the winner. For the second year in a row, Technology Transfer (Kentucky's LTAP) won in a landslide.



Looking back → **Moving Forward**

The Kentucky LTAP started in 1983 with two employees. In the 80s, the average number of courses a year was less than ten. Since then, the Kentucky LTAP has grown its staff to an office of eleven and expanded its trainings to offer an average of 350 courses both online and in person, training over 8,000 participants a year.

In 1988, the Roads Scholar Training Program started with six graduates. In 2021, 214 individuals completed the program. The program has graduated 4,086 participants.

Over the years, the Kentucky LTAP has developed new programs to serve and engage locals, such as Local Road Safety Plans, Safety Circuit Rider Program, and the Road Safety Champion Program.

Cheers to another 40 years of making roads safer for transportation employees and the traveling public.



HIGHLIGHTED PUBLICATIONS AND PRESENTATIONS

- **Xu Zhang, Reg Souleyrette, Eric Green, Alex Wang, Mei Chen, and Paul Ross** received the 2021 Best Paper Award from the TRB Freeway Operations Committee for their paper, "Collection, Analysis, and Reporting of Kentucky Traffic Incident Management Performance". (Traffic & Safety)
- **Lammers, E., Staats, W.** "Evaluation of Orange Pavement Striping for Use in Work Zones," Transportation Research Board Annual Meeting, January 2022, Washington, D.C. (Traffic & Safety)



- **Sana, B., Zhang, X., Castiglione, J., Chen, M., Erhardt, G.** "Using Probe-Based Speed Data and Interactive Maps for Long-Term and COVID-Era Congestion Monitoring in San Francisco", Transportation Research Record, 03611981211069961. (Traffic & Safety)
- **Zhang, X., Chen, M.**, "A Methodology for Conflating Large-Scale Roadway Networks", accepted for publication in Transportation Research Record. (Traffic & Safety)
- **Zhang, X. and Chen, M.**, "Statewide Truck Volume Estimation Using Probe Vehicle Data and Machine Learning", under review by Transportation Research Record. (Traffic & Safety)
- **Tanzen, R., Souleyrette, R., Wang, T., Staats, W.** "Incorporating Crash Severity to Improve Highway Safety Project Prioritization," Road Safety and Simulation 2022, Athens, Greece; 2022. Submitted to Accident, Analysis & Prevention for possible publication. (Planning, Traffic & Safety)
- **Tanzen, R., Souleyrette, R., Green, E., Stromberg, A.** "Improving Safety Performance Function Model Fit Using Exploratory Regression Techniques," Roadway Safety and Simulation 2022, Athens, Greece; 2022. Submitted to Accident, Analysis & Prevention for possible publication. (Planning, Traffic & Safety)
- **Stamatiadis, N, Green, E., and Weast, J.** "A guide of effective countermeasures for low volume road fatalities in the Southeast USA," Roadway Safety and Simulation 2022, Athens, Greece; 2022. Submitted to Advances in Transportation Studies for possible publication. (Traffic & Safety)

HIGHLIGHTED PUBLICATIONS AND PRESENTATIONS

- **Pratelli, A., Van Duin, R., Souleyrette, R., Bianchini, B., Marigo, D., Brocchini, L., Teng, W.** (2021). "Dry port network model: best practices in the EU with notes from the USA," *International Journal of Transport Development and Integration*, 5(3), 217–230. (Planning)
- **Wang, T., Souleyrette, R.** "Data-Driven Rail Safety Assessment for Connected and Autonomous Vehicle at Highway–Rail Grade Crossings," Paper #22–03663, National Academies Transportation Research Board (TRB) 101st Annual Meeting, Washington DC, January 2022. (Planning)
- Paper and Presentation on "A Mixed-Mode Survey Analysis of a Customer Satisfaction Intervention with the Kentucky Department of Vehicle Regulation," National Academies Transportation Research Board (TRB) 101st Annual Meeting, Washington DC, January 2022. (presented by Andrew Martin, ITS)
- Presentation on "Linking Bad Credentials to Safety Issues" at Southeast CMV Safety Research Summit (May 17, 2022). (presented by Andrew Martin, ITS)
- **Sharifi, H., Peiris, A., Harik, I.E.** "A Triage Method for Load Rating Bridge Size Two-Cell RC Box Culverts for the HL-93 Truck," *Structures and Infrastructure Engineering*, <https://www.tandfonline.com/doi/full/10.1080/15732479.2021.2015793> , appeared Online in December 2021. (Structures)
- **Jawdhari, A., Peiris, A., and Harik, I.E.** "Load Rating of Bridge Size RC Arch Culverts," *Structure and Infrastructure Engineering*, <https://doi.org/10.1080/15732479.2020.1850803>, Vol. 18, No. 3, March 2022, pp. 362–375. (Structures)
- **Hutchinson, C., Peiris, A., Harik, I.E.** "Load Testing and Rating of a Concrete Arch Bridge," *International Conference on Structural Engineering and Construction Management (ICSECM2021)*, Kandy, Sri Lanka, December 17–19, 2021. pp. 16. (Structures)
- **Jawdhari, A., Peiris, A., Harik, I.E.** "Evaluating the Bond Characteristics of Intermediate and Ultra-High Modulus CFRP Laminates Adhered to Steel," *10th International Conference on FRP Composites in Civil Engineering (CICE 2020)*, Istanbul, moved to December 8–10, 2021, pp. 10. (Structures)
- **Jawdhari, A., Harik, I.E.** "Analytical Study on the Bond Between CFRP Rod Panels and Concrete Substrate," *8th International Conference on Advanced Composite Materials in Bridges and Structures (ACMBS)*, Sherbrooke, Quebec, Canada, August 5–7, 2021, 6 pp. (Structures)

ITS PROGRAM FUNDING AWARDS

• HIGH PRIORITY ITD FY 21 GRANT AWARD (FULL AWARD - \$1,100,000, KTC - \$515,000)

Cloud Observation System (\$300,000) (OIT/COT)

Enhancements to the Overweight and Over-dimensional System (\$210,000) (KYTC and OIT/COT)

KATS Expansion and Enhancements (\$600,000) (KTC and KYTC)

• HIGH PRIORITY CMV SAFETY FY21 AWARD (FULL AWARD - \$429,500, KTC - \$329,500)

Advancing Universal ID Through Demonstration of Enabling Technologies (\$429,500) (KTC and KYTC)

• MCSAP INNOVATIVE TECHNOLOGY DEPLOYMENT MAINTENANCE & OPERATIONS FUNDS FY21 (FULL AWARD - \$1,259,947, KTC - \$308,657)

KTC Projects include:

ITD & PRISM Administrative and Technical Program Support (\$149,000)

ITD & PRISM Training for Enforcement (\$26,000)

Data Quality Initiatives (\$25,000)

Maintenance of Roadside Screening Systems (\$108,657)

• CDLPI FY 2021 GRANT AWARD

Kentucky CDL Adjudication Project (\$198,000) (KTC Project)

Hosting, Maintenance, and Enhancements to Kentucky's mCDL Software (\$192,600) (KSP Project)

CDL Information Technology Enhancements (\$577,500) (OIT/COT Project)

COMPLETED STUDIES/PROJECTS (WITH PI LISTED)

- Linking Bad Credentials to Safety Issues – Martin
- IFTA/IRP Data Quality Study – Martin
- Weigh-Mile Tax Evasion of Unscreened Motor Carriers A Pilot Study- Martin
- Illegal Weigh Station Bypassing Study – Martin
- Optimizing CVE Investments and Activities – Howell/Walton
- Commercial Vehicle Parking Monitoring – Beaven
- mCDL Evaluation – Walton
- Manual Infrared Brake Systems Evaluation – Beaven/Crabtree
- In-Cab Alert System for CMVs – Howell
- Replacement of Roadside Screening Equipment – Beaven
- Roadside Screening Maintenance – Beaven
- ITD Data Quality Initiative – Walton
- Administrative & Technical Support for Kentucky's ITD and PRISM Programs – Walton

RESEARCH PUBLICATIONS

REPORT NUMBER	AUTHORS	TITLE/UK KNOWLEDGE LINK
KTC-21-07/SPR20-590-1F	Van Dyke et al.	Economic and Environmental Benefits of a Reduced Roadside Mowing Program for Kentucky Highways
KTC-21-20/SPR18-566-1F	Lammers	Evaluation of Liquid Deicing Materials for Winter Maintenance Applications
KTC-21-11/KHIT136-1F	Clay-Young and Waddle	Understanding and Efficiently Managing Right-to-Take Challenges in Kentucky
KTC-21-15/SPR19-570-1F	Marks et al.	Analysis of Truck Weight Limit Regulations
KTC-21-25/SPR20-582-1F	Ammar et al.	Evaluating the Safety Cultures of Kentucky Transportation Cabinet Maintenance Crews
KTC-21-01/SPR17-545-1F	Van Dyke et al.	Initial Project Estimates for Design, Right of Way, Utilities, and Construction
KTC-21-05/SPR20-592-1F	Catchings et al.	Evaluation of the Kentucky Transportation Cabinet's Maintenance Rating Program
KTC-21-12/SPR18-562-1F	Gibson et al.	Project Management Research Support
KTC-21-26/KSP2-21-1F	Green et al.	Analysis of Traffic Crash Data in Kentucky 2016-2020
—	Green et al.	Kentucky Traffic Collision Facts 2020
KTC-21-21/SPR21-5602-1F	Green and Ross	Crash Data Analysis Tool 2.0 Research Report and User Guide
KTC-21-28/RSF19-73-1F	Howell et al.	In-Cab Alert System for Commercial Motor Vehicle Drivers
KTC-21-27/KSP1-17-1F	Lammers et al.	2021 Safety Belt Usage Survey in Kentucky
KTC-18-09/SPR17-534-1F	Kissick et al.	Improving Overweight and Over-Dimensional Logistics and Truck Routing
KTC-20-30/SPR17-551-1F	Wells et al.	Longer Service Life Bridge Coatings
KTC-21-22/SPR20-589-1F	Marks et al.	A Review of Kentucky's Extended-Weight Hauling Programs

RESEARCH PUBLICATIONS

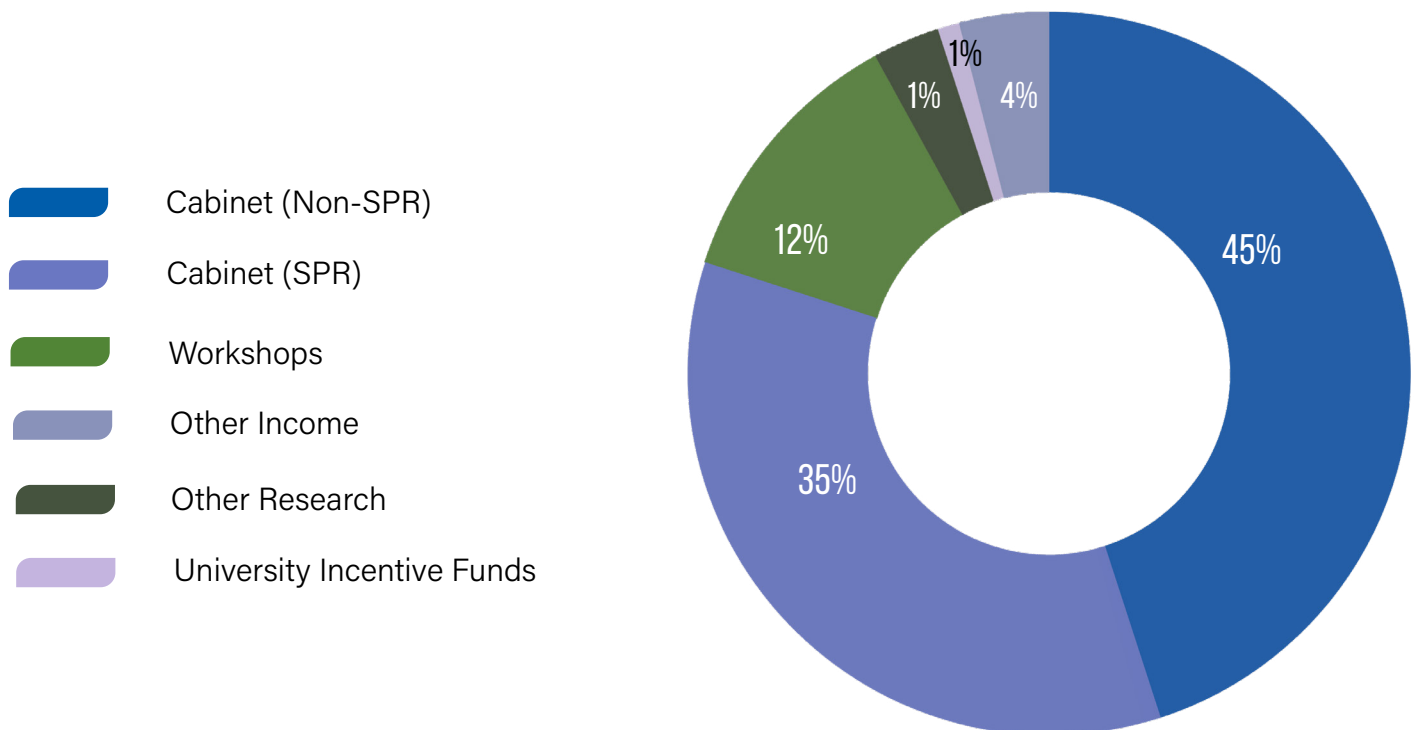
REPORT NUMBER	AUTHORS	TITLE/UK KNOWLEDGE LINK
KTC-21-24/SPR20-591-1F	Gibson et al.	Best Practices for Performance Measurement in Transportation Operations and Maintenance
KTC-21-18/PL39-1F	Chen et al.	Updating Congestion Performance Measures for SHIFT 2022
KTC-22-01/SPR21-611-1F	Howell et al.	Optimizing Commercial Vehicle Enforcement Investments and Activities to Improve Safety and Increase Revenue Collections
KTC-22-03/SPR19-572-1F	Sun and Beckham	Fill Materials at Integral End Bents
KTC-22-06/RSP19-71-1F	Crabtree et al.	Evaluation of Manual Infrared Brake Screening Technologies
KTC-22-02/KHIT147-1F	Van Dyke et al.	Electric Vehicles: Analysis of Revenue Issues and Charging Station Implementation Plans
KTC-21-06/SPR19-573-1F	Rister et al.	Non-Nuclear Methods for Compaction Control of Unbound Soil and Granular Layers
KTC-21-32/SPR15-505-1F	Hopwood et al.	Assessment of Deteriorated Structural Concrete to Provide Durable Repairs

FINANCIAL REVIEW

Although the Center receives most of its funding from the KYTC, researchers often compete for and win awards from the NCHRP, FHWA, and from other organizations. Another major source of income is the workshops and trainings T2 delivers throughout Kentucky. A small portion of KTC's funding comes from legislative appropriations and university incentive funds.

FY2022 FUNDING SOURCES

Cabinet SPR	\$3,599,550
Cabinet Non-SPR	\$4,568,082
Other Income	\$434,618
Other Research	\$337,214
University Incentive Funds	\$113,221
Workshops	\$1,231,793
TOTAL	\$10,284,478

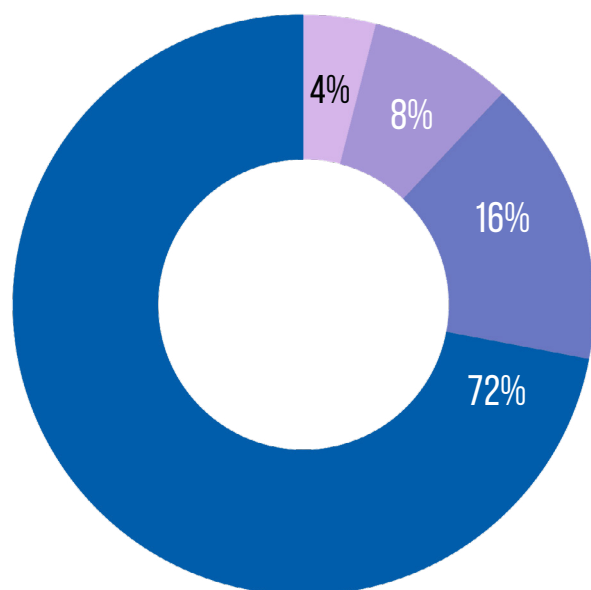


FY 2022 EXPENDITURES

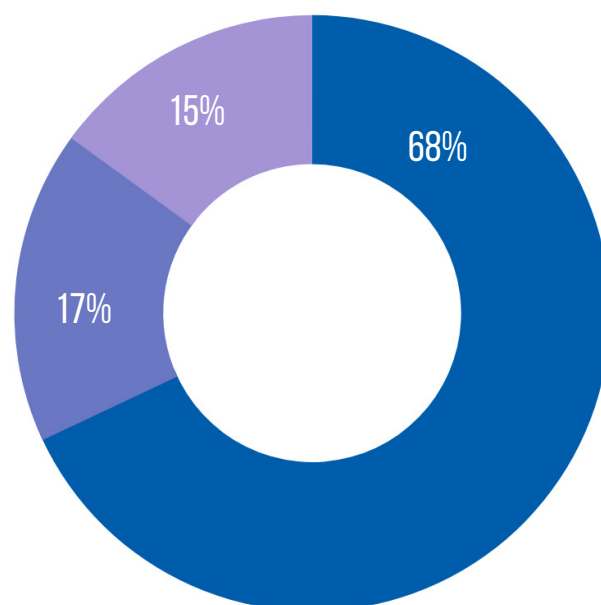
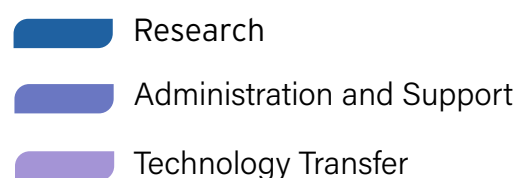
	RESEARCH	ADMINISTRATION & PROGRAM SUPPORT	TECHNOLOGY TRANSFER	TOTAL EXPENDITURES
Personnel	\$5,446,534	\$1,192,380	\$812,105	\$7,451,019
Operating	\$467,636	\$469,193	\$745,725	\$1,682,554
Equipment	\$373,459	0	0	\$373,459
F&A	\$736,567	\$40,879	0	\$777,446
TOTAL PROGRAM	\$7,024,195	\$1,702,452	\$1,557,830	\$10,284,478

KTC categorizes expenditures by category and functional group. The three functional groups are research projects, administrative support, and technology transfer. The four categories are personnel, operating costs, facilities and administrative expenses (paid to UK), and equipment. Looking at expenditures by category, nearly 75 percent of the funds KTC spends go toward personnel salaries, while much smaller percentages are dedicated to operating and equipment costs. In terms of functional groups, 68 percent of expenditures are directed toward research projects and 17 percent to technology transfer – a 55 percent increase over FY 21.

EXPENDITURES BY CATEGORY



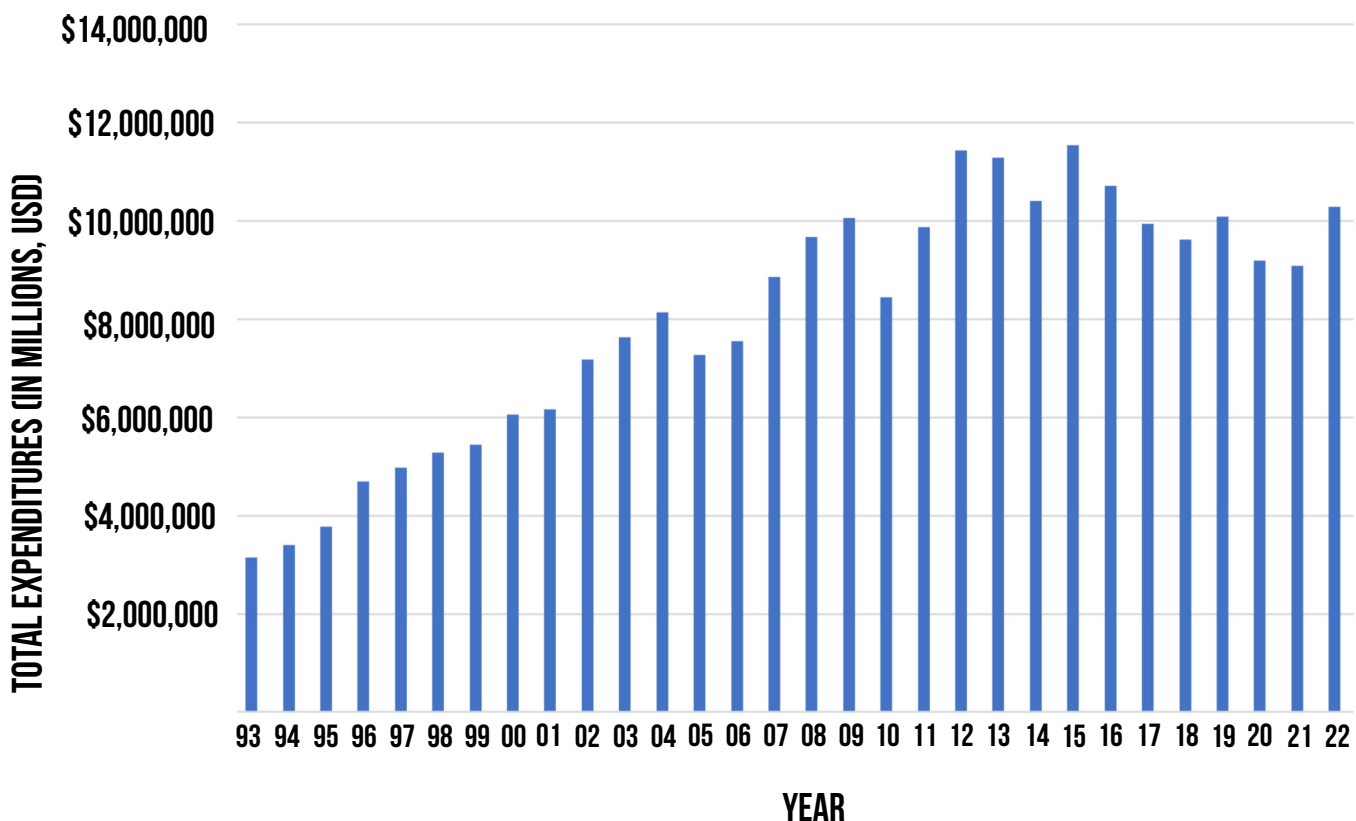
EXPENDITURES BY FUNCTION



FINANCIAL REVIEW

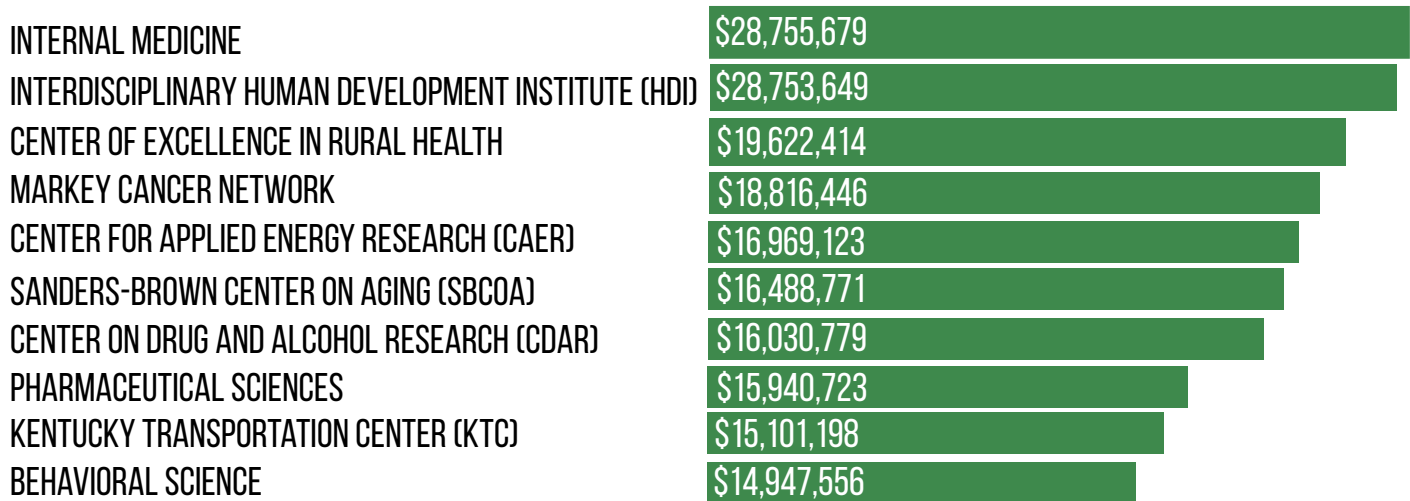
In FY 20 and 21, the COVID-19 pandemic adversely impacted research awards and income from technology transfer activities. The effects can be seen in the budget totals below. Project awards rebounded in FY 22 and reached their highest level since FY 16.

ANNUAL BUDGET TOTALS SINCE FY 93

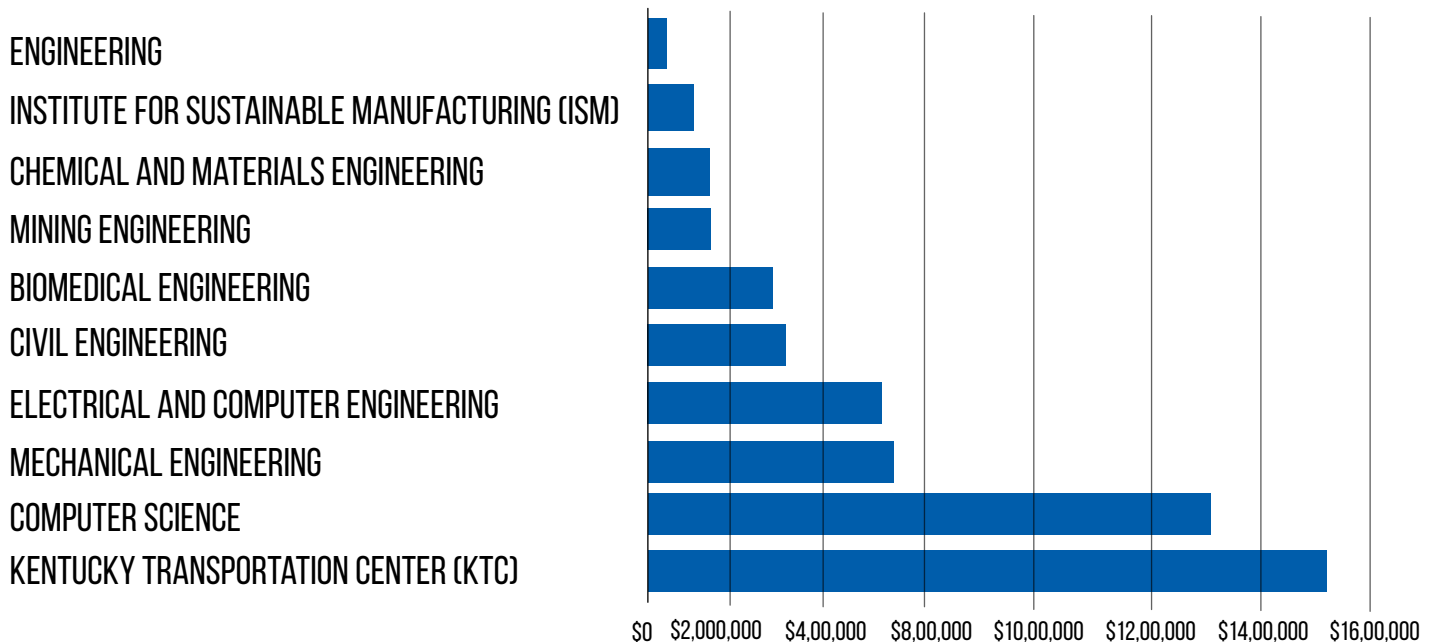


FINANCIAL REVIEW

TOP 10 UK CAMPUS RESEARCH AWARDS FOR FY 22



COLLEGE OF ENGINEERING RESEARCH AWARDS FOR FY 22



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RESEARCH SUMMARIES





Assessment of Deteriorated Structural Concrete to Provide Durable Repairs

The Challenge



Approximately 27,000 structural elements on Kentucky bridges are made of reinforced/prestressed concrete. Many of these elements deteriorate from the corrosion of reinforcing steel caused by carbonation and application of chlorides. Evaluating and repairing these elements poses one of the greatest maintenance challenges the Kentucky Transportation Cabinet (KYTC) faces. There are a wide range of nondestructive evaluation (NDE) techniques available to assess reinforced concrete bridge elements. According to a 2016 survey, many state transportation agencies (STAs) are not using all available NDE methods, KYTC included. This study explored a variety of NDE methods and minimally invasive tests that could be incorporated into KYTC's biennial bridge inspection process and maintenance practices.

Research Project

Assessment of Deteriorated Structural Concrete to Provide Durable Repairs
Report #
KTC-21-32/SPR15-505-1F

Principal Investigators

Theodore Hopwood, P.E.
Research Engineer

Christopher Goff
Transportation Technician

Sudhir Palle, P.E.
Program Manager

David Tipton
KYTC Contributor

Study Timeline

Completed November 2021

Building Solutions

- Researchers reviewed procedures other STAs and KYTC officials use to assess structural concrete, focusing on NDE methods and laboratory and field tests that evaluate structural concrete for chloride contamination, rebar corrosion, concrete chemical assessment, and deterioration.
- Because considerable research has been done on NDE and bridge deck repair, the report addresses issues with other bridge elements (beams, piers, abutments, barrier and retaining walls).
- Two vendors performed field demonstrations of concrete and NDE test equipment so that KYTC could become familiar with the equipment and procedures required to assess reinforced concrete.

Finding Solutions

Both routine and preventive maintenance are the most proactive ways to help preserve reinforced concrete and minimize future deterioration/repairs. Routine maintenance can include tasks such as removing debris, washing bridge elements, opening drains, cleaning gutter lines, cutting brush abutting the bridge, or stream upkeep. Preventive maintenance tasks can be directed by routine inspections and NDE assessments. Those tasks may include application of surface sealers and coatings, sealing cracks, and electrochemical treatments. A product of this research is guidance for the use of advanced structural concrete evaluation methods, analysis of test results, scoping of work, and proper reporting of findings to facilitate preventative maintenance or repairs.

Recommendations

- Provide a structured plan for protecting reinforced concrete elements on bridge members.
- Review NDE and test methods discussed in this report and provide district personnel with the equipment and training needed to evaluate reinforced concrete bridge elements other than decks.
- Develop training for district personnel on the selection of NDE methods and tests.
- Initiate a pilot program in one district to address routine and preventive maintenance focused on reinforced concrete bridge elements.
- Pursue future research on concrete with structural issues, subsidence, or constraint issues. While repairs that involve electrochemical methods are discussed briefly, KYTC has not employed this technology.

KTC: A History of Excellence in Transportation

Since 1981, The Kentucky Transportation Center (KTC) has been a nationally recognized leader in applied transportation research. Multidisciplinary teams provide innovative research, exemplary technology transfer, and real-world education to the transportation community. KTC maintains its strong collaborative relationship with KYTC by delivering projects in the state highway plan and aiding the implementation of research findings. The Center also partners with federal, state, and local agencies, private stakeholders, and other university transportation centers to develop transformative solutions to the most pressing issues facing all modes of transportation.



Electric Vehicles: Analysis of Revenue Issues and Charging Station Implementation Plans

The Challenge



Electric Vehicles (EVs) have many benefits, including the reduction of environmental pollutants and lower costs associated with maintenance and fuel. Automakers are ramping up production of EVs and promising to phase out vehicles that have internal combustion engines (ICEs). Three types of EVs are available:

- Hybrid electric vehicles (HEVs), which have both an ICE and battery,
- Plug-in hybrid electric vehicles (PHEVs), which have both an ICE and a larger battery that can run the vehicle for short distances, and
- Battery electric vehicles (BEVs) which run entirely on battery power.

Research Project

Electric Vehicles: Analysis of Revenue Issues and Charging Station Implementation Plans
Report #
KTC-22-02/KHIT147-1F

Principal Investigators

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Research Engineer

Andrew Martin, Ph.D.
Research Scientist

Jeeyen Koo, M.S.
Research Scientist

Doug Kreis, Ph.D., P.E.
Director

Study Timeline

Completed March 2022

Finding Solutions

Widespread adoption of EVs poses challenges to state government policies and to the planning of infrastructure needed for charging facilities. To help inform the decision making of KYTC leadership, researchers at the Kentucky Transportation Center (KTC) projected fuel tax revenue losses, examined Kentucky's current charging station infrastructure, and summarized the approaches other agencies have adopted to increase the number of EV corridors.

Key Takeaways

EV Infrastructure:

- In 2016, 391 BEVs were registered in Kentucky. This number jumped to 3,621 by the end of 2021 - a 59.3% increase.
- To keep pace with the expected uptick in EV ownership in Kentucky, the number of charging stations must continue to grow and should be distributed more evenly throughout the state.
- In many states, grants and federal funds have been directed toward installing electric vehicle service equipment and infrastructure. Several state governments are working with multiple stakeholders to identify charging station locations and coordinate corridor planning.

Fuel Tax Revenue Loss:

- Federal tax credits for EVs are being depleted rapidly. While the future of federal incentives is unclear, states, power companies, and other entities continue to offer incentives like tax credits and rebates.
- Researchers estimated a projected fuel tax revenue loss of about \$14.2 million per 100,000 vehicles. Since 2016 the state has likely lost over \$1.3 million in revenue.
- Many states have embraced annual fees on BEVs and hybrids to make up for lost fuel tax revenues. Kentucky will benefit from charging an annual registration fee of \$150 for non-commercial BEVs.
- Another potential option for recovering fuel tax revenue loss is an road usage charge (RUC), which levies a fee for each mile driven.
- The combined accessibility of L2 charging stations and DC fast chargers appears reasonable for most current EV owners in Kentucky, with 86 percent of non-Tesla owners and 89 percent of Tesla owners being able to travel 10 miles or less to the nearest station.

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Non-Nuclear Methods for Compaction Control of Unbound Soil and Granular Layers

The Challenge



In highway construction, the correct soil compaction must be attained before construction activities begin. The nuclear density gauge (NDG) is widely used at state transportation agencies (STAs) for measuring soil density and moisture, but because they emit radiation NDGs are expensive to maintain and have unique storage requirements. Operators must earn specialized certifications and adhere to rigorous safety protocols. Equipment manufacturers have introduced several non-nuclear density gauges that eliminate the certification and training requirements and have fewer costs and logistical hassles – although their accuracy has sometimes not equaled NDGs. Kentucky Transportation Center (KTC) researchers performed a comparative field study of NDGs and the eGauge and explored other stiffness/strength devices that can be used as alternatives to NDGs.

Research Project

Non-Nuclear Methods for Compaction Control of Unbound Soil and Granular Layers

Report #

KKTC-21-06/SPR19-573-1F

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Research Engineer

Tim Jones
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Chris Van Dyke, Ph.D.
Research Scientist

Study Timeline

Completed March 2021

Building Solutions

The team collected over 100 soil density and soil moisture measurements at nine field sites across Kentucky. The test sites were classified into four groups based on soil characteristics: 1) silt/clay and shale, 2) stabilized clay, 3) clay, and 4) full depth reclamation (FDR). Soil moisture readings from NDGs and the eGauge were compared to samples dried in an oven laboratory.

Finding Solutions

- Across all sites, 82.5% of the NDG and eGauge density readings were within +/- 5% of one another.
- In silt/clay soils, shales, and stabilized clays, the eGauge produced sufficiently similar soil density readings to those of the NDG.
- At sites with clay or FDR, the eGauge density readings differed significantly from NDG measurements. Before employing eGauge on these types of sites, further study is needed.
- While no significant differences were noted in moisture readings for stabilized clays, for the other soil types, the eGauge returned lower measures of soil moisture than NDGs and the lab samples.
- The eGauge, unlike the NDG, does not have a back scatter mode. It can only obtain a density reading in the direct reading mode by driving the probe into the soil. Therefore, soil densities obtained on projects mixed with rock and/or FDR projects can vary greatly. The eGauge may not be suitable for projects such as these.

Future Considerations

- A promising non-nuclear alternative for evaluating in-place soil properties is measuring soil stiffness/modulus instead of soil density.
- Portable soil stiffness gauges and light weight deflectometers produce accurate measurements while being faster, cheaper, and safer to use than NDGs.
- 84% of STAs use NDGs for in-place density-moisture measurements, while 70% do not use any stiffness/strength methods.
- Some STAs have tried using stiffness/strength methods: it appears the GeoGauge and LWD were tried by roughly 50% of STAs, while the Clegg Hammer (15%) and DCP (32%) have been less widely used.

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Evaluating the Safety Cultures of Kentucky Transportation Cabinet Maintenance Crews



The Challenge

Between 2003 and 2017, over 1,800 workers died on road construction sites. To eliminate injuries and deaths, state transportation agencies must cultivate a strong and positive safety culture. Although there is a clear relationship between a positive safety culture and worker behaviors, workplace culture is not easily defined and can be difficult to measure. To understand the safety cultures of Kentucky Transportation Cabinet (KYTC) maintenance crews, researchers at the Kentucky Transportation Center (KTC) conducted a survey based on the Safety Climate Assessment Tool (S-CAT) developed by the Center for Construction Research and Training (CPWR).

Research Project

Evaluating the Safety Cultures of Kentucky Transportation Cabinet Maintenance Crews
Report #
KTC-21-25/SPR20-582-1F

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Study Timeline

Completed August 2021

Building Solutions

- The safety assessment tool used in this study is the first tool developed exclusively for the construction industry.
- The survey was distributed via Qualtrics to all KYTC maintenance Superintendents I and II, who were told that responses would remain anonymous.
- Questions addressed eight safety climate categories: employee risk perception, management commitment, aligning and integrating safety as a value, ensuring accountability at all levels, improving supervisory leadership, empowering and involving employees, improving communication, and safety training.
- Respondents assigned ratings on a five-point Likert scale – Inattentive (1), Reactive (2), Compliant (3), Proactive (4), Exemplary (5).

Finding Solutions

The survey generated 143 responses from staff across the Cabinet's 12 districts. Analysis of survey responses at the statewide and district levels found that KYTC's safety climate score is 3.71, which is characterized as between compliant and proactive. The highest scores were in the categories Aligning and Integrating Safety and Improving Supervisory Leadership. KTC researchers followed up by meeting with focus groups of maintenance superintendents in two districts. To evaluate the Cabinet's current safety culture, groups discussed eight elements of organizational life: Safety Controls, Routines, Rituals, Stories, Symbols, Power, Safety Structures, and Underlying Assumptions.

Recommendations

KYTC can adopt several practices across the organization to achieve excellence in safety:

- Use formal incentives to recognize crews for positive safety performances.
- Continue using routines that are already integrated into Cabinet practices – weekly safety meetings, job hazard analyses, and toolbox talks.
- Continue to ensure that KYTC staff feel empowered to speak up when conditions are deemed unsafe, and to discontinue work until the hazard passes or can be mitigated.
- Add multiple layers of defense to prevent accidents – safety controls, consistently practiced routines, symbols, and structures.
- Use stories as a powerful way to communicate potential jobsite hazards and preventive actions that can be taken to reduce the likelihood of injuries.

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Analysis of Truck Weight Limit Regulations

The Challenge



On interstates the maximum allowable gross vehicle weight (GVW) is 80,000 pounds. Each state determines its own rules for permitting oversized and overweight (OD/OW) vehicles. Many vehicles that carry specific commodities are exempt from standard weight limits. To help mitigate the infrastructure damage caused by heavy loads, researchers at KTC investigated strategies that Kentucky can adopt to modernize and standardize enforcement of OD/OW vehicles.

Research Project

Analysis of Truck Weight Limit Regulations
Report #
KTC-21-15/SPR19-570-1F

Principal Investigators

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Doug Kreis, PhD., P.E.
Director

Study Timeline

Completed June 2021

Building Solutions

- Studied national laws pertaining to OD/OW vehicles.
- Reviewed Kentucky Revised Statutes and Kentucky Administrative Regulations that govern the permitting of OD/OW vehicles.
- Surveyed state DOTs and law enforcement agencies about truck weight limit policies and regulations.

Finding Solutions

- KYTC district staff share the concerns of other states – that bridge and highway networks cannot support overweight vehicles and believe many roadways are not designed to withstand GVWs of 80,000 pounds.
- States surveyed feel that permitting fees and fuel taxes are insufficient to ameliorate roadway damage caused by OD/OW vehicles.
- Heavier vehicles with commodity exemptions are especially damaging to collector and local roads.
- Reduced funding and staff shortages make enforcement a challenging proposition.
- Several Kentucky statutes and regulations pertaining to OD/OW vehicles are obsolete, contain ambiguous language, or contradict one another.

Recommendations

- Consider changes in legislation and judicial practices such as reducing the number of commodity exemptions or using axle-based weight limits.
- To improve pavement design for heavier vehicles, increase data collection on the weights of trucks involved in crashes and the impacts of truck traffic on bridge deck deterioration.
- Implement advanced technologies to improve tracking of OW vehicles (e.g., scale houses, advanced WIM, mobile unit automated systems, GPS).
- Increase the issuance of citations through targeted efforts and track the commodity the vehicle is carrying when cited.
- Increase fines for violations and better prosecute citations.
- Increase law enforcement staffing and resources by creating enforcement units that focus on OW vehicles.
- Integrate GIS data into KYTC's interactive route maps and revise the Metal Commodities Hauling Network map.

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Best Practices for Highway Project Scoping

The Challenge



One of the Kentucky Transportation Cabinet's (KYTC) foremost priorities in fulfilling its mission is to deliver successful projects. A successful project meets the defined scope with quality solutions and is delivered on time and within the budget specified in the highway plan. A 2002 AASHTO study found that a focus on pre-construction activities is one of four indicators that can be used to measure agency effectiveness. Good project scoping includes a detailed project description that addresses the purpose and need and clearly communicates what the project will and will not deliver. Ideally a project scope is defined in the early phases of the highway project development process. KYTC initiated a study to help program and project managers strengthen scoping processes in order to clearly and accurately identify project needs, better control project development activities, optimize resource use, keep activities on schedule, and improve project outcomes.

Research Project

Best Practices for Highway Project Scoping
Report #
KTC-23-08/ SPR22-632-1F

Principal Investigators

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Study Timeline

Completed August 2022

Building Solutions

This research defines principles to (1) help KYTC programmatically improve its project scoping, (2) identify tools and processes to facilitate programming, and (3) help program and project managers narrow and hone a project's scope before it is established in the Highway Plan. KTC researchers performed a literature review, analyzed peer state scoping processes, and held several KYTC brainstorming workshops which unveiled valuable insights into current scoping practices.

Finding Solutions

The research team investigated scoping processes for several different project scenarios:

- Different project scales: minor, intermediate, major
- Several project types: (1) Capital Improvement Projects (i.e., Mobility and Economic Development), (2) Safety, (3) Asset Management (i.e., Bridges/ Pavement), and (4) Maintenance and Operations
- The first 0-3% of project development and up to 30% of project development (when the environmental phase is complete)

Recommendations

- Throughout the study researchers documented project scoping practices by project type.
- Each recommended best practice was described by its title, background information, goal, implementation strategies, and a ranked score for implementation effort and value to KYTC.
- Best practices were grouped into the following categories: (1) Human Resource-Focused Practices, (2) Programmatic Changes, (3) Project-Level Improvements, and (4) Secondary Best Practices.
- The best practices for Capital Improvement projects had universal application across project types, so a General Best Practices category was created. Eight general best practices were selected as top practices:
 - Strengthen Commitment to Robust Scoping and Lengthen Early Project Stages
 - Ramp Up Project Development Activities During Scoping
 - Increase the Number of Project Managers
 - Multidisciplinary Coordination and Risk-Based Scoping
 - Cross Program Coordination and Collaboration
 - Scoping and Project Delivery Performance Measures
 - Scoring of Project Alternatives
 - Increase Human Resources for Project Scoping

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Evaluation of Manual Infrared Brake Screening Technologies

Background



Due to limited staff and resources, only a small percentage of the commercial vehicles passing through Kentucky each day can be screened or inspected by enforcement personnel. Inspection facilities need the best available tools and technologies to assist them in selecting trucks for inspection so they can focus on those carriers and vehicles most likely to be in violation of laws and regulations. Kentucky has used infrared (IR) technology for approximately 20 years, providing enforcement personnel with visual indicators to identify trucks with brake or tire deficiencies. With the goal of enhancing the quality and efficiency of Level 1 safety inspections, KTC worked with enforcement personnel at two inspection facilities to test the value of IR technology in identifying trucks with safety-related brake and tire violations.

Research Project

Evaluation of Manual Infrared
Brake Screening Technologies
Report #
KTC-22-06/RSF19-71-1F

Principal Investigators

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Study Timeline

Completed April 2022

Building Solutions

The two sites selected to install and operate manual IR brake screening systems were eastbound Lyon County (on I-24 in western Kentucky) and Rowan County (on westbound I-64 in eastern Kentucky). The addition of an IR radio button feature allowed a direct comparison of number of violations identified per inspection and out-of-service rates for IR-generated inspections versus all other inspections. The Rowan County facility lacked sufficient data over the project timeline, so the evaluation focused on inspections at the Lyon County site for a 60-day period during September and October 2021.

Finding Solutions

- When IR technology was used to select trucks for inspection, nearly 100% found violations, with more than three violations found per inspection. Brake and tire violations were found more frequently.
- The Out-of-Service (OOS) rate for IR inspections was 74%, compared to 41% for all inspections.
- Inspectors favored implementing the technology at all inspection facilities in Kentucky so that everyone could be trained to use the system and gain experience.
- Inspection personnel felt the technology helped them do their jobs more efficiently, and they preferred selecting trucks for inspection based on visual indications instead of a credentials flag.

Recommendations

The conclusions of this study were based on limited data from one facility. Additional data should be collected and analyzed to determine if the system continues to benefit inspection facilities. Strong consideration should be given to installing this technology at additional sites, with the eventual goal of making it available at all fixed enforcement locations.

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Combined Behavioral and Engineering Approach to Preventing Highway Fatalities



The Challenge

Traditional approaches to highway safety can be augmented through multidisciplinary approaches that consider both engineering and behavioral interventions. The primary focus of this study was on behaviors targeted in Kentucky's Strategic Highway Safety Plan such as aggressive driving, distracted driving, impaired driving, and driving without proper restraint. The research team sought to understand factors that affect driving behaviors and crash probabilities in order to improve safety across the state. Factors included latent conditions (e.g., demographics, socioeconomics) and proximate influences (e.g., vehicular and roadway factors) on crashes.

Research Project

Combined Behavioral and Engineering Approach to Preventing Highway Fatalities
Report #
KTC-23-01/SPR21-601-1F

Principal Investigators

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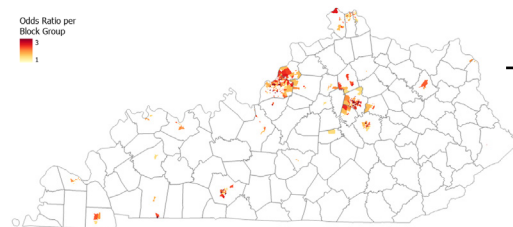
Erin Lammers, P.E.
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Study Timeline

Completed August 2022

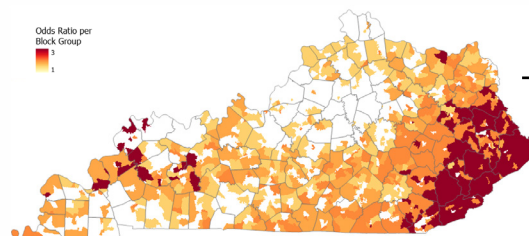
Building Solutions

- Reviewed literature from public health and systems-based approaches to safety.
- Utilized a systems-based framework of roadway safety data, statistical and geospatial analysis, and SPF modeling and network screening.
- Examined a data set of over 500,000 crashes in Kentucky between 2014 and 2018 to generate statistical models that predict crashes involving risk-taking behaviors.
- Developed an analytical framework to help understand the variables that influence crash occurrences and outcomes.



All aggressive driving crashes

This map shows the results for all aggressive driving crashes and demonstrates a clear connection between urbanized areas, and in some cases wealthy suburbanized areas, and aggressive driving crashes. College towns are also implicated.



Severe aggressive driving crashes

This map shows the results for all severe (fatal or incapacitating injury) aggressive driving crashes. In this map, rural areas, including southeastern and parts of western Kentucky, demonstrate increased likelihoods.

Key Takeaways

Researchers proposed a process that identifies when and where behavioral modification strategies could complement or substitute for engineering strategies. In some cases, a behavioral-related modification may be more effective than an engineering solution. The result is a tool practitioners can use to identify communities and corridors where a high number of behavioral-related crashes occur. This in turn can inform the selection of countermeasures.

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A Review of Kentucky's Extended-Weight Hauling Programs

The Challenge



Kentucky established its Extended Weight Coal or Coal Byproducts Hall Road System (EWCHRS) to increase the state's competitiveness within the coal industry and reduce financial burdens on coal haulers. A new extended-weight haul system for unrefined petroleum products will be implemented in 2022, and further expansion of extended-weight hauling is possible. The Kentucky Transportation Cabinet asked KTC to examine current laws and strategies related to vehicle weight limits and identify methods for improving the state's extended weight limit policies.

Research Project

A Review of Kentucky's Extended-Weight Hauling Programs

Report #

KTC-21-22/SPR20-589-1F

Principal Investigators

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Doug Kreis, PhD, P.E.
Director

Study Timeline

Completed November 2021

Building Solutions

- Surveyed literature on how overweight vehicles affect the integrity of roads and bridges.
- Described Kentucky statutes and regulations pertaining to the EWCHRS and vehicle weight limits.
- Reviewed policies and strategies used in other states to handle extended-weight hauling.
- Surveyed personnel at other state transportation agencies about challenges related to weight limit policies and regulations.

Finding Solutions

Overweight loads are getting heavier, presenting safety hazards and increasing damage to roads. Roads and bridges that are continuously exposed to overweight vehicles have shorter service lives, and there are few methods for quantifying rates of deterioration. Combined with these factors, there are several reasons the current level of revenue collected from permitting fees is not sufficient to offset damage caused by overweight trucks:

- Some vehicle owners run overweight because the resulting fines and fees can be less expensive than obtaining the correct permit.
- Enforcing overweight trucks is complicated by exemptions that apply to specific industries and commodities.
- Inadequate staffing and inconsistent weigh station operating schedules further hamper enforcement.

Recommendations

- Investigate the feasibility of a statewide long-haul network with weight limits based on axle weight and wheelbases that accommodates all commodities.
- Modify the EWCHRS fee structure by either raising decal fees, including a higher flat rate based on truck configuration, or enacting a fee structure similar to Kentucky's Weight Distance tax.
- Strengthen enforcement of weight limits on the EWCHRS by imposing more stringent penalties.
- Mandate installation of GPS systems on vehicles that travel the EWCHRS to streamline mileage reporting and improve driver awareness of routes that cannot accommodate their vehicles.
- Eliminate inconsistencies, ambiguities, and redundancies in regulatory and statutory language and establish regulations that address specific commodities.
- Establish a centralized, easy-to-search database that provides more information on routes, networks, and construction lettings.
- Review how EWCHRS routes are displayed/characterized on parkways that end at interstates.

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Fill Materials at Integral End Bents

The Challenge



Jointless bridge designs have become increasingly popular at state transportation agencies (STAs) due to their low construction and maintenance costs. However, there are risks associated with the design. Soil movement in embankments and loads carried by the superstructure can displace integral end bents. The Kentucky Transportation Cabinet (KYTC) addressed this challenge by placing elasticized geofoam between the soil and the integral end bent. There are issues with this treatment – the geofoam is expensive and the design needs to be modified in the location where the geofoam and overlying pavement meet. KYTC asked researchers at the Kentucky Transportation Center (KTC) to identify less costly materials that would reduce the settlement of integral end bents.

Research Project

Fill Materials at Integral End Bents

Report #

KTC-22-03/SPR19-572-1F

Principal Investigators

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KYTC Contributors:
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Michael Carpenter

Study Timeline

Completed March 2022

Building Solutions

- Established a lab procedure to evaluate the recoverable deformation and maximum resistant stress on different integral end bent samples.
- Evaluated seven materials derived from recycled tires to determine which have similar elastic properties to elasticized geofoam.

Finding Solutions

Two lower cost materials were selected: shredded tire chips and recycled tire granules. The shredded tire chips performed the best in terms of recoverable deformation, but the resistant stress was less than that the geofoam tested at the same strain. Recycled tire granules exhibited the best performance for both resistant stress and recoverable deformation.



Installing chips or particles on construction sites is the biggest challenge in using these alternative materials. Researchers developed two step-by-step installation procedures: 1) recycled tire derivatives are delivered in bags and stacked against the back of the end bent/abutment, and 2) bulk-packaged recycled tire derivatives are placed into baskets located against the back end of the bent/abutment.

Recommendations

KYTC has not yet identified a demonstration project to test the use of tire derivatives and the proposed installation methods. An implementation study will follow when the Cabinet selects a site.

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