Kentucky Transportation Center

College of Engineering

Research Previews - FY 2010

Fall 2009

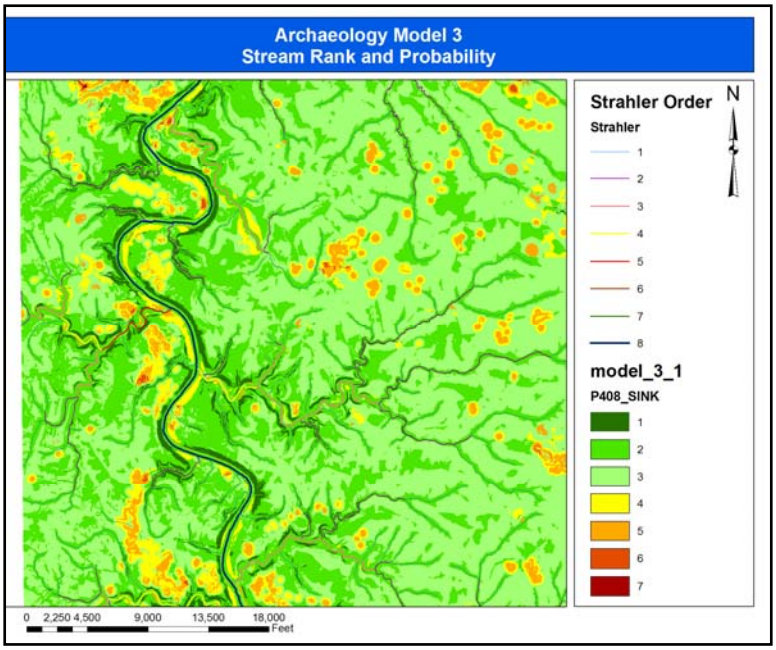
Twenty-three new research studies were begun during 2009/2010 on a wide range of topics as highlighted below. For more information on these projects, please contact the Kentucky Transportation Center or the staff person listed. These projects are being conducted for the Kentucky Transportation Cabinet.

Sealants, Treatments and Deicing Salt Practices to Limit Bridge Deck Corrosion (Study #10-388)

Bridge deck repair/replacement is a major maintenance expense for agencies. Those are primarily caused by the ingress of deicing salts into deck concrete and subsequent corrosion of deck reinforcing steel. This project will determine current Cabinet practices for applying deicing salts to bridge decks including monitoring deicing materials, methods of deicing application (i.e. wet/dry), application frequency and application rates statewide. Candidate bridges will be identified for annual monitoring of all deicing salt application, chloride penetration and resultant deck deterioration (spalling and/or corrosion). The Center will be providing recommendations to implement bridge preservation actions including the application of sealers, densifiers, and/or inhibitors. Guidelines for using those treatments on specific categories of bridges will be provided. Additional recommendations will be provided for the use of effective salt substitutes, inhibitors and extenders or related treatments/practices found to be effective will also be recommended.

(*Contact: Ted Hopwood, (859)-257-2501, thopwood@engr.uky.edu) [Study Advisory Chair: Nasby Stroop]*

GIS Archeological Predictive Modeling Phase III (Study #10-389)

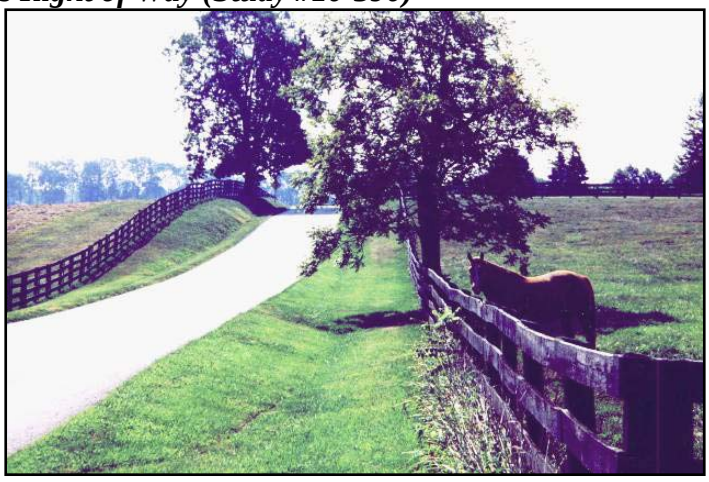


Previous research applied the Woodford County model across the inner Bluegrass Region and a modified version to Pike County, as a test bed. The results of those applications have been reviewed and revised models will be tested. This modeling process is being revised to better account for lake impoundments, an infrequent occurrence in the Bluegrass, and mining and road construction, which have greater impacts in the more mountainous regions of eastern Kentucky.

This project will take the existing Pike county archeological modeling protocol and extend it across the Hazard Hills Physiographic Region. Working in cooperation with the existing research team, Center researchers will explore the nature of model modification necessary to adjust for a broader, but similar, spatial context for archeological sites. This project will develop a predictive surface for the Hazard Hills Physiographic Region as well as exploring the potential for new model parameters such as underlying geology, so that future modeling approaches can be as uniform as possible across the state.

(Contact: Ted Grossardt, (859) 257-7522, thgros00@pop.uky.edu) [Study Advisory Chair: Carl Shields]

Develop Consistent Guidelines for Disposition of Excess Right of Way (Study #10-390)



The Cabinet finds itself with roadbed and its associated right of way no longer germane to the state-maintained road system for a variety of reasons with the result that it is responsible for maintenance of and potentially liable for problems on roadways with their associated rights-of-way, scattered across the state. How to manage and minimize the Cabinet's financial and legal exposure is currently not clearly spelled out. This study will draw on current Kentucky and other states' experiences and legal outcomes to develop more consistent and clear policies for the use, management, and disposition of non-germane ROW. This ROW is the result of rebuilds or re-alignments, but continues to be controlled by the Cabinet. The following questions will be addressed: 1) 1)The willingness and financial capacity of local vs. state government to maintain the bypassed sections; 2) differences in the way long bypassed loops or roads no longer germane to the system are handled as opposed to shorter distances; 3) methods pursued by other states to facilitate surveys and applications to receive bypassed roadways which will promote the Cabinet's aim of reducing the state-maintained mileage. *(Contact: Ted Grossardt, (859) 257-7522 or Len O'Connell (859) 257-7556, loco0@engr.uky.edu) [Study Advisory Chair: Carol Brent]*

Developing and Implementing Strategies to Address "Freddie the Free-Roader" (Study #10-391)

Due to shortfalls in fuel tax and usage tax collections, Kentucky's Road Fund is over $100 million under budget. Usage tax collection on first time registration of motor vehicles has always been an area of concern due to the practice of some Kentucky residents licensing their vehicles in one of our surrounding states. Depending on the licensing and tax laws of the other state, a Kentucky resident might be able to avoid the 6% usage tax, the annual property tax, and even the requirement to show proof of insurance at the time of licensing. The objectives of this study are to: 1) determine to what extent taxes and insurance requirements are being avoided by licensing vehicles outside of Kentucky; and 2) implement and evaluate strategies to identify those residents who are violating Kentucky's registration statutes.

(Contact: Mark Bell, (859) 257-7244, markbell@insightbb.com) [Study Advisory Chair: Rick Taylor]

Analysis of Geologic Context of Transportation Maintenance Costs (Study #10-392)

Each year a variety of maintenance activities and their costs are compiled into the Cabinet's Operations Management Systems (OMS). Some of the maintenance activities reported, such as rock falls and landslides, are related to underlying geologic materials and conditions. Analysis of the costs of the associated landslides and rock falls, in the context of their geologic and geographic setting could provide improved prediction of future maintenance costs in different parts of the state. This analysis could also be expanded into other areas. The objectives of this project are to: 1) acquire OMS cost data for pertinent types of maintenance activities, 2) develop a spatially referenced layer of OMS cost data, 3) compare cost data associated with the maintenance activities with available geologic information, and 4) develop predictive tools to assist in long-range planning of maintenance activities.

(Contact: Jerry Weisenfluh, (859) 257-5500x114, jerryw@uky.edu) [Study Advisory Chair: Bill Broyles]

Improved Longitudinal Joint Construction (Study #10-393)

Poor compaction practices at construction joints in asphalt pavement lead to premature pavement failure. Previous research studies have indicated that densities are significantly lower at the longitudinal joint than in the center of the lane, leading to increased deterioration of the joints. The Center conducted previous studies and trial projects of a variety of construction techniques, including the notched wedge, the restrained edge, the joint reheater, and the Joint Maker. In addition, a number of joint adhesives were used. A recent review of these projects after six to seven years of service did not indicate these techniques performed better than the control sections which were constructed using conventional construction techniques.

This project's first year will consist of a review of the specifications and construction techniques of other state agencies to determine the current state of practice. In addition, selected projects being constructed using the reduced gyration levels for mix design during 2009 will be evaluated. Based on these reviews, pilot projects will be identified for construction during 2010 and 2011. These trial projects will include a test section using a specific technique or piece of equipment along with a control section using conventional techniques.

(Contact: Clark Graves, (859) 257-7388, cgraves@engr.uky.edu) [Study Advisory Chair: Allen Myers]

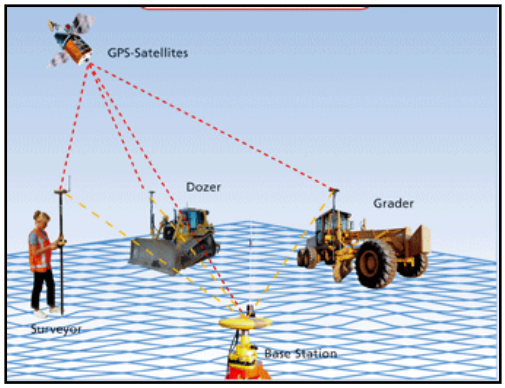
Evaluation and Monitoring of Kentucky's New Pipe Policy (Study #10-394)

Kentucky has recently changed its pipe policy to require the video inspection of storm sewer and culvert pipe installations along with laser deflection testing of flexible pipes. The utilization of these policies is a significant change in the post construction inspection requirements for drainage structures. The Center has two other drainage pipe projects: "Pipe Performance in Kentucky" and "Evaluation of Pipe Linings and Coatings". These projects have been combined as a joint project since both require a significant amount of inspection and evaluation of in-situ pipes.

It is anticipated that the "New Pipe Policy" project will be an extension of the projects which are currently underway since the results of these current projects will directly influence the direction of the "New Pipe Policy" project. It is anticipated that in the later stages of this project Kentucky's fill height tables will be streamlined to facilitate a more efficient design process. The objectives of this project are to: 1) monitor installation and inspection of culverts and storm sewers installed using the pipe policy dated August 2008, 2) conduct random evaluations of each pipe type being installed (CMP, RCP, HDPE, and PVC, 3) evaluate the effectiveness of the new pipe policy, 4) review pipe policies and design guidelines for other agencies, and 5) develop a strategy to update and revise the current Culvert Fill Height Tables.

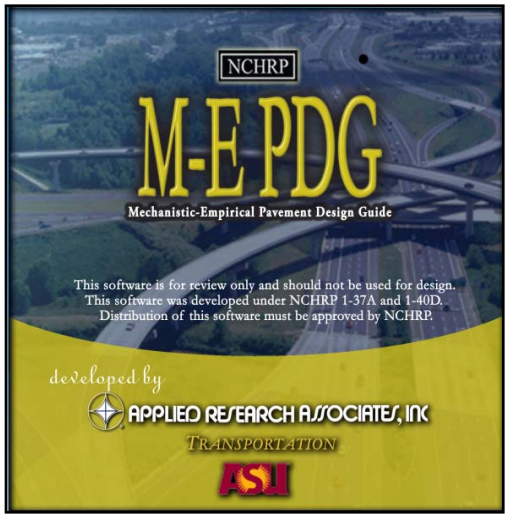
(Contact: Clark Graves, (859) 257-7388, cgraves@engr.uky.edu) [Study Advisory Chair: David Moses]

Design and Construction Coordination to Facilitate GPS Machine Control (Study #10-395)



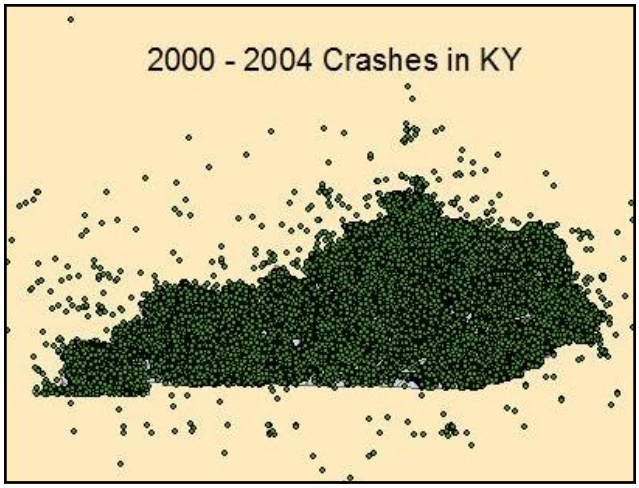
GPS machine control has been utilized by a number of contractors in Kentucky in recent years. Problems have existed for Cabinet construction personnel checking projects which have been setup using GPS surveys. This facilitates the need to have appropriate coordination between the highway designers and the Cabinet's construction staff along with highway contractors to utilize this technology. Kentucky has received several grants through the National Height Modernization program sponsored by NOAA; this program has worked to establish the CORS network across the country. New technology may facilitate the use of this network for machine GPS control. An issue which has been observed nationally is that the plans and elevation models developed by designers may not have the types of information necessary for incorporation into a three-dimensional elevation model utilized by construction equipment. Also, coordination problems between the survey control used for design and that used for construction have resulted in several elevation discontinuities during construction resulting in delays and in some instances change orders on projects in Kentucky. (*Contact: Brad Rister, (859) 257-4513, brister@engr.uky.edu) [Study Advisory Chair: Steve Criswell]*

Local Calibration and Strategic Plan for Implementation of AASHTO Mechanistic Empirical Pavement Design Guide (MEPDG) (Study #10-396)



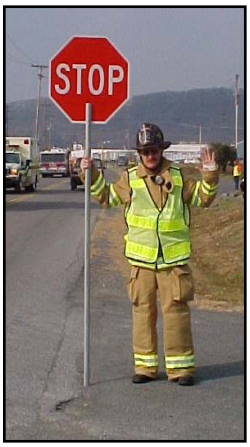
Kentucky has been very active in the evaluation and implementation of the new MEPDG procedure. Before the guide can be used on a routine basis to design and evaluate pavements, a strategic plan and local calibration must be completed. This will ensure that the predicted performances produced by the guide will match conditions which are observed in Kentucky. A past research study "Evaluation and Implementation Issue for the 2002 Pavement Design Guide" developed default levels of input levels for the design guide. In addition, initial work has been completed to develop strategic plans and support the Cabinet's involvement in MEPDG User Groups. Also, "Identification and Determination of Distress Levels and Rehab Cycles" identified initial distress levels utilized by the new design procedure. The objectives of this project are: 1) to review current activities relating to local calibration procedures of the NCHRP MEPDG; 2) select in-service pavement sections to correlate predicted performance with actual performance to adjust the MEPDG prediction models; 3) develop appropriate calibration factors for each predicted distress, and 4) develop a detailed implementation plan for integration of the new design guide into Kentucky's design process. *(Contact: Clark Graves, (859) 257-7388, cgraves@engr.uky.edu) [Study Advisory Chair: Paul Looney]*

Update CRASH Analysis Tools: Buildup and Critical Rate Calculator (Study #10-397)



The primary objective of this study is to update the functionality and distribution process of crash analysis tools previously developed. Included will be an update of the crash analysis programs: Buildup and Critical Rate Calculator (CRC), and the process to calculate intersection rates. Currently these tools are standalone applications that require administrative installation and contain a very large database. Additionally, a database update is required each year in order to keep the data current. Frequently, the need exists to revise and update the analysis software. A web-based format for implementation of these tools will eliminate these issues. The study advisory committee will provide guidance on specific features and functionality appropriate for inclusion in these tools. A training program or workshop will also be developed to inform and instruct users on the tools and provide background on their development. *(Contact: Eric Green (859) 257-2680, egreen@engr.uky.edu) [Study Advisory Chair: Jeff Wolfe]*

Evaluation of Pilot Project: Emergency Traffic Control for Responders (Study #10-398)



The Kentucky Transportation Cabinet is funding a pilot project to distribute emergency traffic control equipment to fire departments along the I-65 corridor from the Kentucky/Tennessee line through Hardin County. Fire departments with trucks that access this segment of I-65 will be provided with an emergency traffic control kit to use at the scene of crashes. The equipment will include: 10 retroreflective safety vests; 2 flagger paddles; 18 traffic cones; and 6 advance warning signs. The objective of this evaluation is to determine if emergency traffic control equipment kits provided as part of this pilot project are appropriately utilized by emergency responders and to measure the benefit of their use for responders and motorists. Log sheets will be kept by participating fire departments to collect information on when the kits are utilized. Surveys will be distributed to all responding agencies each time the kits are utilized to help determine the value of their use. (*Contact: Jennifer Walton, (859) 257-7239, jwalton@engr.uky.edu) [Study Advisory Chair: Tracy Lovell]*

Roadway Related Tort Liability and Risk Management (Study #10-399)

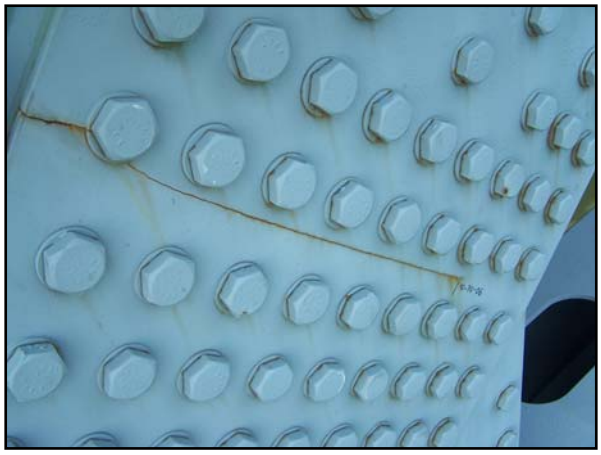
One of the categories listed as a contributing factor on the traffic collision report form is roadway-related factors such as inadequate drainage or improper traffic signs. In the past, Board of Claims cases against the Cabinet have been reviewed and summarized. The results have been used to: a) develop recommendations to reduce crashes involving roadway related issues and b) provide background for a workshop taught as part of the Technology Transfer program offered by the Center. The most recent summary provided data through 2001. There is a need to update this data. Board of Claims data will be obtained through 2009 for cases filed against the Cabinet. Historical data will be updated to provide resolution of old cases. The data will be summarized to provide trends in such areas as the type of claim and the number and type of claims by district. The data will also be used to update the previous workshop material. Workshops will be presented showing the areas where roadway-related factors have contributed to crashes along with recommendations to reduce the number of crashes. *(Contact: Ken Agent, (859) 257-4507, kagent@engr.uky.edu) [Study Advisory Chair: Chuck Knowles]*

Identify Causes and Countermeasures Related to Motorcycle Crashes (Study #10-400)

The number of motorcycle crashes (especially fatal crashes) has increased dramatically in the past few years. The total number of motorcycle crashes increased by 27.3 percent in 2007 (as compared to the previous four-year average) while the number of fatal motorcycle crashes increased by 47.4 percent. The number of fatal motorcycle crashes in 2007 was higher than the number of commercial truck fatal crashes. There was a significant overrepresentation of motorcycles in fatal collisions as compared to involvement in all collisions (a ratio of nearly 10). This is much greater than the involvement ratio for any other type of vehicle. Since repeal of the helmet law in 1998, the numbers of injury and fatal crashes have increased dramatically which corresponds to a significant reduction in helmet usage. Another factor is the increased numbers of motorcycles being registered in Kentucky and nationally. The age and skill level or training received by motorcyclists may be factors influencing increased crashes.

An analysis of data for crashes involving motorcycles will be conducted for a five-year period. A more detailed review and analysis will be performed for fatal crashes to determine contributing factors related to the categories of vehicle, driver, and roadway. Specific characteristics related to motorcycle crashes will be investigated and patterns or trends will be identified. Locations with the highest frequency of motorcycle crashes will be identified and recommendations will be made for countermeasures or improvements. A separate analysis of driver license and motorcycle registration data will be performed.
(*Contact: Ken Agent, (859) 257-4507, kagent@engr.uky.edu) [Study Advisory Chair: Boyd Sigler]*

Kentucky Bridges Incorporating High-Strength Quenched and Tempered (Q & T) Steel (Study #10-401)

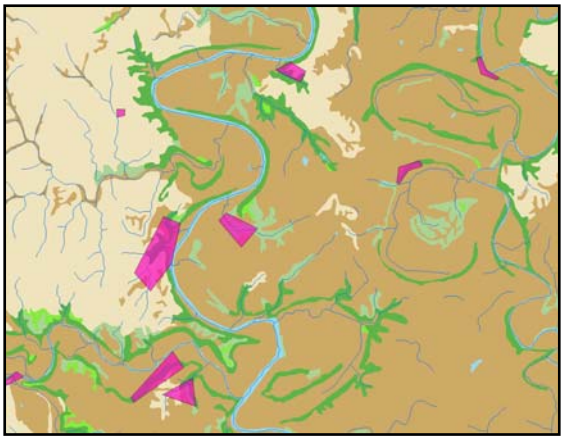


Some Kentucky bridges employing QT steels have had problems with weld cracking, corrosion cracking, and brittle properties. The Cabinet needs to identify all bridges containing QT steels and determine any follow-on action required to properly evaluate them. This project will: 1) conduct a literature review to determine when high-strength quenched and tempered (QT) steels were first employed on bridges in the US; 2) review the evolution of the ASTM/AASHTO standard steels including adoption of fracture-toughness, susceptibility to weld cracking and stress cracking sand stress corrosion/ hydrogen stress cracking; 3) review the Kentucky's bridge inventory to identify existing steel bridges that could have potentially employed high-strength QT steels; 4) review plans/materials lists for the bridges that potentially could possess QT steels and identify any that contained those steels; and 5) perform hardness tests on potential bridges/structural members where documentation is lacking to determine if they possess QT steel. The Cabinet will be provided with a list of bridges containing QT steel along with recommendations/guidelines for follow-investigations, inspections and testing to preclude the presence of defective material or potential problematic details/ issues. (*Contact: Ted Hopwood, (859) 257-2501, thopwood@engr.uky.edu) [Study Advisory Chair: David Steele]*

Identification of Secondary Crashes and Recommended Countermeasures (Study #10-402)

For all roadway users, the probability of a secondary crash increases immediately when an incident occurs, and the risks remain high until the incident is cleared. Some secondary crashes are more severe than the initial incident. Previous studies have attempted to quantify this type of crash as one of the peripheral effects of an incident and have had limited success due to the complexity of identifying such a crash. In 2008, Kentucky's Uniform Police Traffic Collision Report implemented a separate code identifying a "secondary collision". The study will analyze secondary crashes as coded on the Uniform Police Traffic Collision Report. All crashes listed as a "secondary collision" will be analyzed and general characteristics will be summarized. An in-depth review will be performed on selected incidents involving secondary crashes. A separate case study-type analysis will be performed for crashes on selected sections of interstate in Kentucky. The objective will be to improve the process for identification of secondary crashes and recommend countermeasures to reduce their frequency and severity. (*Contact: Jerry Pigman, (859) 257-4521), jpigman@engr.uky.edu) [Study Advisory Chair: William Hayes]*

Predictive Model for Threatened and Endangered Species (Study #10-403)



As part of the NEPA process, the Environmental Division of the Transportation Cabinet must be responsive to the Kentucky Department of Fish and Wildlife when it makes determinations about potential impacts on threatened and endangered species. Since much of this determination hinges on impacts on habitat associated with particular species, better understanding of the habitat combinations and locations will allow the Cabinet to avoid obvious problems and be more practical in its planning decisions. Working with Cabinet Environmental staff, researchers will develop the logic of relationships between habitat properties that are available or can be derived from existing GIS databases for purposes of these "rules" to create predictive models for the likelihood of the occurrence of certain threatened and endangered plant species. *(Contact: Ted Grossardt, (859) 257-7522, thgros00@pop.uky.edu) [Study Advisory Chair: Barry Nichols]*

WIM Data Collection and Analysis (Study #10-404)

WIM data has traditionally been used primarily for pavement design, bridge design, highway cost allocations, and to determine the characteristics of vehicles traveling on roadways. The use of weight data has been in integral component of the procedure for estimating ESALs for many years, with earlier use of static weight data now exclusively replaced with WIM equipment. A previous research report recommended more attention to calibration and overall monitoring of WIM equipment. A review of the WIM data collection and analyses, along with evaluation of alternative equipment, will be undertaken to identify a process to improve and optimize procedures to be implemented by the Cabinet's Division of Planning. The Transportation Center will assume responsibility for WIM data collection, monitoring, and quality control to the extent directed by the Division of Planning. Currently WIM sites will be evaluated to determine if they are strategically located. Calibration procedures and monitoring procedures will also be evaluated.
(Contact: Jerry Pigman, (859) 257-4521, jpigman@engr.uky.edu) [Study Advisory Chair: Scott Thomson]

Improved Bridge Expansion Joints (Study #10-405)

Both opened and closed bridge expansion joints and associated details have proved problematic. Several joint types are believed to provide superior performance compared to others. Some agencies have modified existing joint types/details to provide improved placement and better performance. The improved performance of expansion joints will increase their durability and prevent damage to underlying bridge components by eliminating joint leakage. The objectives of this project are to: 1) conduct a literature review and survey selected states and the Cabinet's districts to obtain information/opinions about expansion joint/header installation, performance, and special maintenance requirements/practices; 2) obtain cost, performance data, specifications, installation instructions, and maintenance requirements on specific joint designs from manufacturers/materials suppliers; 3) develop guidance on joint selection enumerating preferred joints for both new construction and maintenance and identify joint performance tests that may be used to evaluate new joints after they are placed; 4) review the best performing deck joints and identify potential areas for joint performance enhancements; and 5) assist in the development of experimental projects incorporating bridge expansion joints that offer improved performance and monitor the placement of experimental joints during construction. *(Contact: Ted Hopwood, (859) 257-2501, thopwood@engr.uky.edu) [Study Advisory Chair: Marvin Wolfe]*

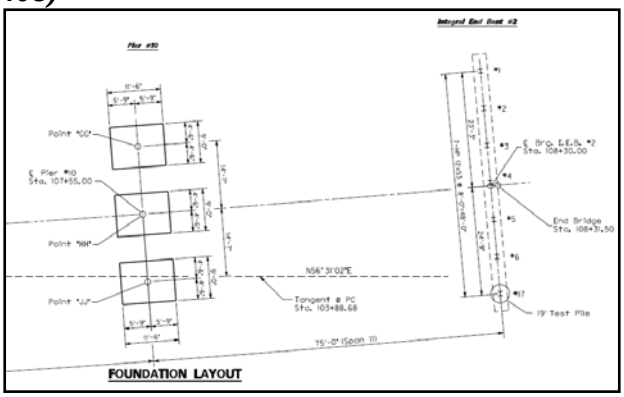
Evaluation of Deterioration of Structural Concrete Due to Chloride Entrainment and other Damaging Mechanisms (Study #10-406)

Structural concrete is widely used in Kentucky bridges, culverts, and other structures. The deterioration of structural concrete in those structures is problematic, with the most prevalent form of distress due to chloride entrainment. Other potential deterioration mechanisms include carbonation, sulfate attack and alkali-silicate reactions. To properly evaluate structural concrete for deterioration, additional tests may be needed beyond visual inspection and sounding. This study will identify the susceptibility of structural concrete in Kentucky to the various forms of deterioration and evaluate advanced test methods used to analyze concrete for those types of distress. Tests will be performed on bridge decks, barrier walls, retaining walls, abutments, beams and piers. *(Contact: Ted Hopwood, (859) 257-2501, thopwood@engr.uky.edu) [Study Advisory Chair: Kevin Sandefur]*

Evaluation of the Use of Painted and Unpainted Weathering Steel on Bridges (Study #10-407)

Weathering steels have proved problematic for exposures involving deicing salts and extended time-of-wetness. Some evidence indicates that once unhindered corrosion begins, this type of steel performs poorly even when subsequently coated. For severe exposures, conventional coated steel may prove more desirable. This project will: 1) review the performance of uncoated and coated weathering structural steels and associated problems with corrosion on highway applications; 2) conduct laboratory accelerated weathering/corrosion tests of painted/uncoated weathering and conventional steels of various grades along with equivalent grades of conventional structural steels; and 3) provide recommendations on the use of weathering steels for applications involving complete and/or spot painting. *(Contact: Ted Hopwood, (859) 257-2501, thopwood@engr.uky.edu) [Study Advisory Chair: Michael Baase]*

Effect of Thermal Loads on Bridge Substructures (Study #10-408)



The design of footings for short bridge piers is primarily controlled by the AASHTO thermal loads requirements. Accurate estimates of the thermal loads on footings is essential for proper design and can be achieved by instrumenting footings in new bridges, monitoring the soil pressure on the footing under different ambient conditions for a period of three or more years, and by comparing the actual soil pressure with ones estimated by the AASHTO code equations. The objective of this study is to instrument, on a multi-span bridge, the bottom horizontal surface at the base of the footing of the pier with five soil pressure cells and temperature gages, and instrument the vertical face of the footing and pier with three temperature gauges each, and to continuously monitor the soil pressure and temperatures and compare the soil pressures with one derived using the AASHTO code. *(Contact: Issam Harik (859) 257-3166, iharik@engr.uky.edu) [Study Advisory Chair: Kevin Standefur]*

Evaluation of Warm-Mix Asphalt (Study #10-409)

Warm-mix asphalt technology is becoming more prevalent in routine highway construction across the county. It provides many benefits over conventional hot-mix asphalt (HMA), including reduced mixing and placement temperatures, lower fuel consumption, and the potential to realize easier placement. There are a variety of technologies utilized for achieving lower mixture temperatures, including the use of chemical additives, the use of organic additives (primarily wax-based), and injection of water into a typical HMA mixture, sometimes referred to as “foamed asphalt”. However, temperature reduction may be limited more with the “foamed” method than with the additive methods. Kentucky has utilized the “foamed” technology on two projects on the shoulders of interstate highways. One of the projects exhibited some “tenderness” during initial placement. This project will monitor this issue among others associated with the use of warm-mix technology. *(Contact: Clark Graves, (859) 257-7388, cgraves@engr.uky.edu) [Study Advisory Chair: Allen Myers]*

For a copy of a project’s work plan or general information regarding
the Kentucky Transportation Center, contact
Don Hartman, Interim Director
Kentucky Transportation Center
176 Raymond Building
Lexington, KY 40506-0281
Voice: (859) 257-4513 Fax: (859) 257-1815 www.ktc.uky.edu

UNIVERSITY OF KENTUCKY
College of Engineering

KTC