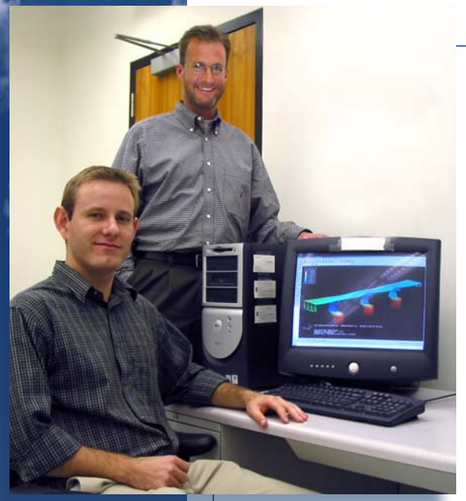

Associate Professor James M. LaFave, standing, with Ph.D. candidate John Bignell, who is teaching the undergraduate course CEE 460 Steel Structures this semester. Bignell is the recipient of the Alumni Teaching Fellowship, an award offered every other year to provide the department's best graduate students with teaching experience. The award also offers support for a semester of research.

Reliable earthquake emergency routes

Southern Illinois lies within the New Madrid Seismic Zone, an area identified by experts as vulnerable to a major earthquake. As part of its earthquake preparedness plan, the Illinois Department of Transportation (IDOT) has designated several main arterial transportation routes as priority emergency routes. In the event of a major earthquake, IDOT would like these routes to remain fully functional to allow emergency personnel and supplies to safely and effectively reach areas of need. A research project by Associate Professor **James M. LaFave** will provide IDOT with valuable information about the seismic vulnerability of hundreds of bridges along these routes.

Working with information from structural drawings of actual IDOT bridges, as well as the results of physical tests done on relevant bridge components, LaFave and Ph.D. candidate John Bignell have constructed three-dimensional computer models of typical wall pier bridges, the second most commonly occurring type of bridge in this region. The most common are multi-column pier bridges, a type examined several years ago using two-dimensional models by Professor Emeritus Neil M. Hawkins. Like that project, LaFave's has used computer modeling to expose the bridges to earthquakes of varying magnitude to see how they might fare.

LaFave's project is unique in its examination of wall pier bridges, offering the first glimpse of their seismic vulnerability, and in its use of three-dimensional modeling to fully address issues such as bridge skew angle. The project has also provided IDOT with detailed inventory information about its bridges, which could be used to identify bridges for seismic retrofitting. The results will give IDOT a better understanding of the earthquake damage the bridges might sustain and the potential for interruption of its designated priority routes.

Safer construction zones

Drivers who speed through construction zones present a danger to construction workers, fellow motorists, and themselves. The sight of a police car curtails speeding, but it isn't feasible to station law enforcement at every construction site. This year Illinois became the first state to try speed photo reinforcement in construction zones, a method that involves catching speeders on camera and mailing them tickets. Toward this end, the Illinois Department of Transportation (IDOT) has acquired vans equipped with computers, radar devices and cameras. In order to study the plan and its effect on overall safety in construction zones, IDOT is funding a study by Professor **Rahim F. Benekohal**.

Benekohal's research will evaluate the effectiveness of speed photo reinforcement by studying various setups involving the vans, signs that warn drivers their speed is being monitored, and lighted displays that inform passing drivers of their actual speed. The researchers will examine the overall impact on safety in the work zone and will consider whether the presence of the equipment causes drivers slam on the brakes or tailgate. One of the most complex aspects of the project will be following the issued tickets through the court system to see if they are upheld. Long used in Europe, speed photo reinforcement has been slow to catch on in the United States, partly because of legal issues surrounding its use.

During this inaugural period, all eyes will be on Illinois as other departments of transportation watch and wait to see whether or not snapping pictures of speeders means safer construction zones for all concerned.

Safe, efficient rail transport

For nearly a century, the motto of the railroad industry has been, 'Safety First.' So it is no surprise that safety is a major research focus of Associate Professor **Chris Barkan**, director of the railroad engineering program. Funded largely by the railroad industry, Barkan and his students are doing groundbreaking work in the areas of railroad train, tank car and hazardous materials safety and risk analysis.

Along with students and colleagues, Barkan is approaching the question using statistical and operations research methods. Among their recent work has been an analysis of the factors affecting the causes and severity of railroad accidents. They have also developed a mathematical model to determine the optimal thickness of tank cars and a multi-attribute analysis to identify the most efficient means of enhancing tank car safety design. The third critical element of their risk analysis work is understanding the characteristics of hazardous materials and their likely impact on humans or the environment if they are released in an accident.

Barkan is also collaborating with faculty from the Beckman Institute on another project to develop machine vision technology to perform safety inspections of railcars more effectively and efficiently.

The longstanding focus on safety has paid off for the rail industry, which in the late 19th century was among the most dangerous occupations. Today railroads are the safest of all transportation modes and among the safest of all industries.

Another of Barkan's research areas is energy efficiency. In one project the loading patterns of intermodal equipment on railcars are being analyzed. An optimization model that accounts for the aerodynamics of different loading patterns has been developed and shown that substantial fuel savings are possible. In another project the feasibility of using energy recovery technology somewhat akin to hybrid automobiles but applied to diesel electric locomotives is being studied.

Effective pavement maintenance

The most common and costly maintenance work performed on highways and airport pavements is the sealing of cracks that develop over time. The sealing of cracks prevents water from entering the pavement and causing more serious, structural damage. Notwithstanding the benefits of crack sealing, the selection of effective sealants is difficult, as traditional methods of testing crack sealants are often poor predictors of field performance. This is in part because current standard tests do not account for field conditions, including simultaneous traffic and environmental loads, and sealant adhesion and rheology, which considers the coupled effect of loading time and temperature. Thanks to research by Professor Imad Al-Qadi, that is about to change.

In collaboration with chemist Dr. J-F. Masson and his group at the Canadian National Research Council, Al-Qadi and his students are developing performance-based guidelines for the selection of hot-poured crack sealants. With support from 13 state departments of transportation in the United States and 13 similar Canadian agencies and industry, the researchers established the Crack Sealant Consortium and embarked on a $1.4 million dollar project. Their work involves the development of test apparatus and approaches to assess the rheological properties of the crack sealants in a wide range of temperatures, the modeling of sealant behavior and developed test procedures based on numerical and finite element analysis, the comparison of laboratory test results and model predictions, the calibration of test procedures against field data, and development of new testing standards.

The project is so unique that the researchers are scheduled to present six papers on their work at the next Transportation Research Board meeting. By 2007, they expect to have developed testing and specifications for determining the best sealant for any region in North America, making unreliable crack sealants—and the unnecessary expense associated with them—a thing of the past.