Kansas State University

# University Transportation Center

## Center Theme: *The Sustainability and Safety of Rural Transportation Systems and Infrastructure*

# Quarterly Report

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## 1) INTRODUCTION

The Kansas State University Transportation Center (K-State UTC) is a research organization dedicated to bringing together transportation professionals, educators, and researchers to identify transportation problems—and to solving them. Partnering with the Kansas and U.S. Departments of Transportation, the K-State UTC has been designated a Tier II University Transportation Center by the Research and Innovative Technology Administration (http://utc.dot.gov).

The theme of the K-State UTC is The Sustainability and Safety of Rural Transportation Systems and Infrastructure. This theme is selected to complement the mission and direction of K-State and to meet the needs of the Kansas Department of Transportation and the rural transportation community as a whole. Research at Kansas State University's UTC also fills a national need—specifically focusing on the sustainability and safety of rural transportation systems and infrastructure in the context of a declining and aging rural population.

K-State is also a partner with the University of Nebraska's Mid America Transportation Center (MATC), which has been designated the Region VII, partnering with Lincoln University, Kansas State University, the University of Iowa, the University of Missouri-Rolla, and the University of Kansas.

Center Director Brian A. Coon is responsible for engaging research faculty in establishing and implementing the Center's research initiatives, as well as establishing a vision for the center. The K-State UTC's Advisory Committee met in the spring of 2007, setting the research agenda, as outlined in the 2006 and 2007 Budget Proposals (available online at http://transport.ksu.edu). The Advisory Committee members are:

Richard McReynolds, KDOT
Paul Malir, TranSystems
J. Michael Bowen, FHWA
W. Michael Lackey, KDOT, Retired
Jim Jones, Kansas Asphalt Pavers Ass'n.
E. Dean Carlson, Carlson Associates
Edward J. Mulcahy, Transystems
Robert Thorn, Finney & Turnipseed
Leon Hobson, Riley County Public Works
Greg Harkrader, Kansas Highway Patrol
Matt Ross, Am. Concrete Pavement Ass'n
Keith Browning, Douglas Co. Public Works
Joanie Roeseler, Federal Transit Administration

## 2) CURRENT UTC ACTIVITIES

One of the primary goals of the K-State UTC is researching rural transportation issues. As part of this goal, the Advisory Committee's selection of research projects has been implemented with funding through Project 8. It is anticipated that, once final Federal funding arrives, the remaining two projects will be funded. These projects are shown in Table 1. Research previously selected under the direction of former Civil Engineering Department Head Dr. Reddi is detailed below through a progress report.

In addition to specifically-designated research selected by the Advisory Committee, the K-State UTC has initiated several other research and outreach efforts. Dr. Renee Slick, Associate Director of the K-State UTC, has begun to work with driver education students at USD 383 Manhattan East High School in research designed to measure the effectiveness of driver education using driving simulators.

For the first time, faculty in the Department of Civil Engineering have completed training to work with human subjects under K-State's Committee for Research Involving Human Subjects (Institutional Review Board, IRB). Drs. Coon and Slick, along with two undergraduate students who are also now certified, have begun using the Driver Behavior Assessment Tool (DBAT) to assess students' behavior. The tool is a computerized questionnaire that evaluates how students' personal attitudes and beliefs are related to involvement in vehicle crashes. This diagnostic tool, combined with the STISIM Drive vehicle simulator software, which was developed by Systems Technology, Inc. was donated to the University Transportation Center for its use in performing research at USD 383.

Dr. Slick, a organizational and industrial psychologist with extensive expertise in driver training and instruction, had initially developed DBAT while working with the Department of Defense in examining driver behavior of soldiers and is a member of the Defense Safety Oversight Council Private Motor Vehicle (PMV) Task Force, which oversees the PMV research for all five branches of the United States military. It is believed that this research will allow better training of drivers, specifically in rural areas where access to urban driving settings is logistically difficult.

The K-State UTC website is available at http://transport.ksu.edu, with links to ongoing research, progress reports, and the Strategic Plan. Dr. Coon was able to obtain donated software for hosting a bulletin board, the National Transportation Forum, which will provide an opportunity for discussion for transportation professionals around the nation, focusing on the areas of expertise of the faculty of K-State.

The UTC has also become actively involved in the Riley County Area Transportation Agency (aTa Bus program) in Manhattan. Dr. Coon is a member of the Board of Directors, serving as an advisor on transit system. Additionally, undergraduate and graduate students have been working as part of the Transportation Planning course taught by Dr. Coon to help develop the Agency's Long-Range Strategic Plan, which is required as Manhattan forms a Metropolitan Planning Organization (MPO) in 2010.

A student chapter of the Institute of Transportation Engineers (ITE) has also been formed at K-State, which previously did not have a student chapter. Twenty-two students have now joined ITE and have begun looking at activities to increase the awareness of transportation engineering at K-State.

Dr. Coon has also been working with Nancy Mattson, looking at options of GIS mapping bike trails. One concept is teaching Boy Scouts, as part of a merit badge or Eagle project, how to use GIS mapping and equipment to map local trails.

The Office of Chief Counsel has also been directly involved with the UTC, developing plans to train local officials on transportation contracts. As tort litigation is already well-covered by the University of Kansas, Leslie Fowler identified a need of local officials to better handle transportation contracts when dealing with non-state-funded projects.

**Table 1. Projects Selected for Funding.**

| PI | Project Title | Project Cost | Accumulative Amount |
|---|---|---|---|
| Peterman | Establishing A Mobile Laboratory for Transportation Research and Education | $32,650 | $32,650 |
| Rys & Russell | Promoting Center Line Rumble Strips to Increase Rural, Two-lane Highway Safety | $20,000 | $52,650 |
| Dissanayake | Factors Affecting Fatal Crash Involvement of Older Drivers | $75,000 | $127,650 |
| Hossain, Testa | Kansas Pavement Preservation Initiative | $120,000 | $247,650 |
| Russell | Increased Pedestrian Safety and Decreased Motorist Delay with a HAWK Pedestrian Signal | $35,000 | $282,650 |
| Rys & Russell | Effectiveness of Larger Traffic Signs, High-Performance Sheeting and Clearview Font on Accident Reduction | $49,000 | $331,650 |
| Dissanayake, Stokes | Improving the Usage of Demand Response Transit Services in Rural Kansas | $80,000 | $411,650 |
| Najjar and Dissanayake | Knowledge Discovery in Transportation Databases (KDiTD) | $180,000 | $591,650 |
| Najjar | Characterizing KDOT's Chloride Permeability Testing Protocol: Reducing the Duration of the Rapid Chloride Permeability Test | $95,000 | $686,650 |
| Dissanayake | Speed Management in Rural Communities: Innovative Low Cost Approaches | $82,000 | $768,650 |

## 3) PROJECT STATUS REPORTS

The 2007 year has been a transitional year for the Department of Civil Engineering. Dr. John English has taken the reins as Dean of the College of Engineering; Dr. James Koelliker has taken over as department head after Dr. Reddi left for Central Florida University; and Dr. Stefan Romanoschi, an expert in pavement testing, as left the department for the University of Texas at Arlington. However, the challenges of this period are being met with great enthusiasm, as it is also the centennial anniversary of the department of civil engineering at K-State

Due to the lack of availability of graduate students in transportation, as well as the changeovers in departmental personnel, several of the projects funded last year by the UTC had neither used significant funds nor made significant progress. Now, graduate students have been located and the research projects are either in full swing or nearing completion at a rapid rate. Additionally, with the new projects funded for the 2007-2008 school year have ensured faculty that they will be able to hire the needed graduate students and be able to promise research projects.

## a) Rural Transportation Initiative Supporting Agricultural Transition and Sustainability

Principal Investigators: Dissanayake, Apley, Steward, and White

Theme: Intelligence, Knowledge, and Information Systems in Transportation

Budget: $50,000

### *1. Overview*

Twenty percent of Kansas' population works within the agriculture sector, bringing $9B in revenues annually to Kansas with $6.5B from cattle production alone. The cattle production industry is supported by a transportation network whereby grains are produced in close proximity to feedlots, which in turn are located close to packing plants. This sector depends upon an irrigated agriculture base, which is going through transition as groundwater-use practices change due to economic externalities and limited availability. This initiative supports key components of this system including:

### *2. Animal Production*

The quality of transportation infrastructure plays a key role in the welfare of animals being moved through the system. Cattle are moved at least 2 times and as many as 3-4 times over their lives, and stress levels from driving conditions are key factors in the quality of meat (dark cutters) and shrinkage (weight loss).

### *3. Transportation Network*

Driving conditions are directly related to pavement and bridge quality, traffic controls, type of road (e.g., freeway vs. gravel), and roadway design characteristics (grades, curves) and operation (speed).

### *4. Resource Proximity and Mobility*

The transportation network (rail and road) connects the components of grain and animal production with markets and the resources (water, soils, etc.) necessary to support the agriculture industry. Whereas 95-98% of groundwater is used in irrigation over a limited growing season in western Kansas, animal production, which requires access to water throughout the year, requires long-term safeguarding of a reliable stock of water.

5. *GIS Support*

Geographic Information Science provides a means to overlay different types of geospatially referenced data (transportation network, location of animal production, water availability) and provides support for resources management.

6. *Economic Impact*

While a direct correlation between animal stress and quality/value of meat is known, the impact of stress induced through transportation is an untapped area of research. Relationships amongst transportation networks and animal production, within a water-dominated system, are also untapped.

7. *Intellectual Merit*

This initiative brings together, for the first time, an interdisciplinary team that synergistically exploits areas of strength at K-State in transportation engineering, water resources/GIS, computing/information sciences, and animal sciences/veterinary medicine. This team will forge new research partnerships across campus and addresses critical issues.

8. *Broader Impacts*

This initiative addresses a transportation programmatic focus with tremendous implications to cattle production and agriculture. Results will support societal decisions in transportation development, animal production practices, and resources utilization. The GIS infrastructure developed here could synergistically leverage other geospatial needs for endeavors related to pavement quality, bridge repair, and the environment.

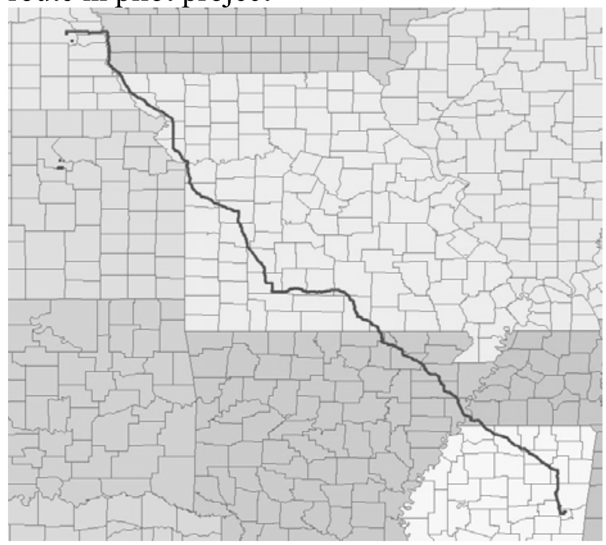
9. *Purpose: Pilot Cattle Transport Sensor Field Evaluation*

To evaluate remote movement sensor systems on animals transported through commercial mechanisms and to collect pilot data that will be used to evaluate system and pursue further funding.

*10. Materials and Methods*

A college of veterinary medicine student (Curt Vogel) employed on project traveled to Mississippi to a cooperating facility. The student placed wireless accelerometers on 16 animals (2 animals in each section of a standard cattle transport truck), and each section of the truck (8 sensors). One sensor was placed on the truck in a fashion to record GPS readings of truck through trip. Figure 1 illustrates the route of the truck over the 19 hour journey. All sensors recorded and logged data to internal memory cards throughout the trip. The student traveled to a feedlot in Nebraska to meet the calves upon arrival and will remove the sensors and bring them back to KSU.

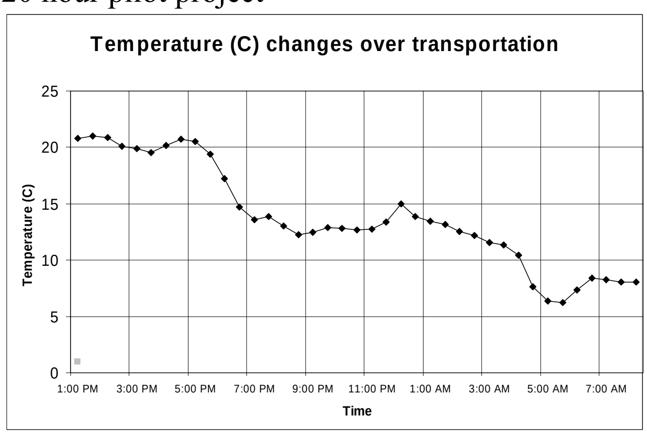
**Figure 1:** GPS record of cattle transport route in pilot project



*11. Initial Results*

Animal sensors consisted of 3-D accelerometers and truck mounted sensors consisted of temperature and barometric pressure monitors in addition to accelerometers. There were 12 sensors placed on the cattle transport trailer throughout the various sections. Temperature data was recorded once per second and acceleration data was logged at a rate of 10 Hz. Due to hardware issues, the 16 animal sensors did not record data through the entire journey; therefore were not included in the analysis.

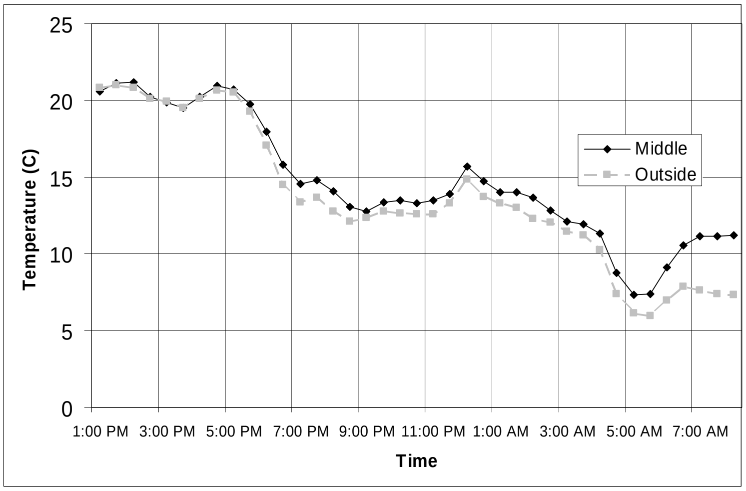
**Figure 2:** Variation in mean trailer temperature over a 20 hour pilot project



One goal of the project was assess environmental changes throughout the journey. Figure 2 represents the difference in temperature as measured by the truck mounted sensors over the journey.

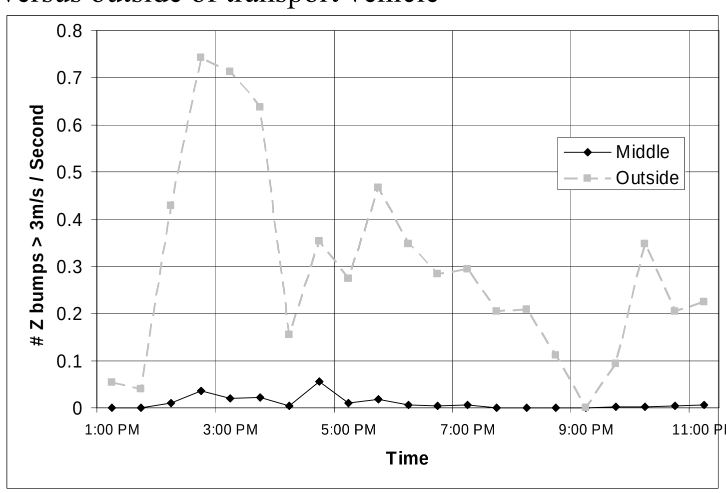
Cattle are commonly divided into 6 or 8 sections on most cattle transport vehicles. The sensors were strategically placed in sections of the trailer to evaluate potential environmental differences by region of the trailer. Minor temperature differences were identified between sections of trailer, but most were related to larger trends within the truck. Differences were also related to specific events that occurred during the journey.

**Figure 3:** Differences in mean temperature over time as recorded by sensors in the middle compared to the outside of the transport vehicle




For example, Figure 3 represents the mean temperature collected by sensors in the middle (near the center) and the outside (placed on the lateral walls of the trailer near ventilation). The two areas mirror each other through most of the journey with the middle sensors maintaining a slightly higher temperature until a little after 5 am when the two have a significant separation. The GPS data illustrates that the truck stopped at 5 am and waited in the same location until 7:15 am to unload the cattle. Thus, the middle of the trailer warmed back up after stop while the outside (near ventilation) stayed relatively cool. This information could be very

**Figure 4**: Difference in the number of Z-axis events greater than 3 $m/s^2$ per second over time in middle versus outside of transport vehicle



valuable when generating guidelines for required rest stops or potential implications for animal health.

Truck sensors also measured forces registered in 3 directions: vertical (Y-axis), horizontal parallel to direction of driving (X-axis) and horizontal perpendicular to direction of travel (Z-axis). These measurements are used to evaluate forces faced by calves during commercial transport. Preliminary data comparison of forces faced by calves in each section of the truck during the trip illustrated differences by area. Published literature has illustrated the potential impact of vibrations or large stressors on animal health. Figure 4 illustrates the difference in the frequency of events greater than 3 $m/s^2$ during the journey comparing sensors in the middle and outside of the transport vehicle.

*12. Summary*

The pilot project data revealed several interesting trends and opportunity for utilization of the data. More data needs to be collected from similar journey's to solidify findings and expand the project. This data will be useful to formulate hypotheses and generate applications for funding from external agencies in the varied fields represented by investigators on the study. Work is planned to continue this summer to augment existing information.

**b) National Rural Transportation Symposium**

Principal Investigator: Hossain

Theme: Outreach

Budget: $50,000

Funds expended (03/31/07): $0

A group meeting of representatives from Kansas State University (KSU), the Kansas Department of Transportation (KDOT), the Federal Highway Administration, the Kansas Asphalt Pavement Association, and the asphalt pavement industry in Kansas was held on April 30, 2007, on the KSU campus. The objective and targeted audience of this symposium were reevaluated in light of other regional and national conferences and role of the KSU University Transportation Center. It was decided that the Principal Investigator will work with the Director of K-State's UTC and will try to arrange a symposium to primarily target the local government management and engineering staff.

The administrative feedback questioned the need for such a symposium since the objectives in the original project have largely been fulfilled (generation of more extramural support). Further investigation is proceeding to determine the needs of the rural transportation community, as well as examining the best options for information dissemination.

**c) Development of a Comprehensive Rural Transportation Safety Research Program for the 21st Century**

Principal Investigators: Dissanayake, Russell, Rys, and Stokes

Theme: Rural Transportation Safety

Budget: $100,000

*1. Objectives*

The objectives of this research project are to: 1) develop a comprehensive, multi-disciplinary rural transportation safety research program for the Kansas State University UTC; and 2) outline the organizational and administrative infrastructure needed to implement the recommended safety research program. It is envisioned that the recommended research program will serve as a guide for the UTC Advisory Committee in the selection of safety research projects in the future.

*2. Work Plan*

The research work plan consists of the following basic tasks. Task 1: Conduct literature reviews to identify current and emerging issues in the area of rural transportation safety. The literature review will be supplemented with the knowledge of the research team and personal contacts. Task 2: Develop criteria for selecting research topics to be included in the research program. Task 3: Prepare interim report. The interim report will provide a summary of potential research areas, a preliminary prioritization of research areas, and a preliminary identification of the disciplines/areas of expertise best suited to address the individual problem areas. The interim report will also outline the organizational and administrative structure needed to implement the research program. Task 4: Conduct interviews, meetings and visioning seminars with KSU faculty whose expertise could be brought to bear on the problems identified in the interim report. The purpose of these interviews will be to link the research needs identified in the interim report with the appropriate KSU faculty. Task 5: Prepare final report. The final report will provide a detailed description of the research "agenda" in the form of a preliminary prioritization of research areas, individual project problem statements, a proposed organizational structure to implement the research agenda, and a proposed technology transfer program to disseminate information on the research program and its findings.

*3. Project Status*

A draft of the project Interim Report has been prepared. Following is a summary of the study results as presented in the Abstract of the Draft Interim Report.

The basic objective of this study was to develop a multi-disciplinary, comprehensive research agenda that can guide the Kansas State University Transportation Center's (KSU UTC) rural transportation safety research program into the 21st century. The products of the research include a description of recommended rural transportation safety research topic areas, a proposed organizational structure to implement the research agenda, and a suggested technology transfer program to disseminate information on the research program and its findings. The research team recommends the following rural transportation safety research topics as focus areas for the KSU UTC: 1) Sustaining Proficiency in Older Drivers and Providing Mobility Options for the Elderly in Rural Areas; 2) Increasing Driver Safety Awareness in Rural Areas; 3) Increasing Seatbelt Usage in Rural Areas; 4) Keeping Vehicles on Roadways in Rural Areas; 5) Making Rural Truck Travel Safer; 6) Enhancing Rural Emergency Medical Capabilities; 7) Designing Safer Rural Work Zones; 8) Improving Design and Operations of Rural Highway Intersections; 9) Creating More Effective Rural Safety Management Systems; 10) Making Non-Motorized Rural Travel Safer; 11) Economic Issues Associated with Rural Transportation Services and Facilities; and 12) Transportation Planning for Terrorism, Natural Disasters, Traffic Incidents and Other Emergencies in Rural Areas. The selection of the topic areas was based on the following criteria: 1) The research area must address one or more of the UTC's strategic research focus areas; 2) The research area must address a "rural" transportation safety issue and have the potential to significantly improve rural transportation safety; 3) The research area should offer substantial opportunities to involve students in the research effort; 4) The research area must have a moderate to high potential to attract regional and national funding; 5) The research area should have the potential for a multi-disciplinary research effort; and 6) The research area must address one of the areas identified in the Kansas DOT Strategic Highway Safety Plan (SHSP). It is the recommendation of this study that the KSU Advisory Committee adopt this research report as a policy guide in the selection of future UTC-funded research projects in the area of rural transportation safety. In ranking and selecting potential safety research projects in the future, it is recommended that the UTC Advisory Committee consider the six "Criteria for Selecting

Research Areas" established by the research team in developing the 12 recommended Research Areas presented in this report. To implement the KSU UTC rural transportation safety research agenda presented in this report it is recommended that the KSU UTC Advisory Committee consider establishing a rural transportation safety "institute" within the KSU UTC.

It is estimated that the Interim Report will be available for distribution to KSU faculty and the UTC Advisory Committee in September 2007. It is estimated that the final project report will be submitted to the UTC Advisory Committee by January 2008.

The project is currently supporting one MS graduate student. It is anticipated that the research project will generate one MS Thesis. The project budget has funds to support the graduate student through April 2008. The research team requests an extension of the project through April 2008 to provide that support.

**d) Intelligent Structural Health Monitoring of Rural Bridges.**

Principal Investigators: Rasheed, Peterman, Esmaeily, and Melhem

Theme: Intelligence, Knowledge, and Information Systems in Transportation

Budget: $100,000

Prepared by Brandon Decker and Hayder Rasheed

*1. Introduction*

The primary purpose of this research is to advance the state of the art in bridge monitoring and repair, with two primary objectives: 1) Establishment of a robust FRP repair and strengthening technique to achieve the actual ultimate capacity without the predominant separation failure mode; and 2) intelligent health monitoring of bridge elements using wireless technology and remote sensing.

*2. Progress towards Objective 1*

Since the last report, all the intended specimens have been tested. A third T-beam was reinforced with the same five layers of flexural FRP reinforcement and fitted with FRP U-wraps to examine prevention of premature debonding of the flexural FRP before rupture of FRP. The beam reached an ultimate load of 33.5 kips (149 kN) when the CFRP ruptured as shown in Figure 1. The FRP U-wraps prevented debonding of flexural FRP and provided a strength increase ratio of 2.16 over the control beam.

Following the T-beams, the same tests were conducted on the rectangular beam specimens. The control beam R1 was tested using the same procedure as for the T-beam. The beam failed at a load of 12.3 kips, which is very close to the theoretical value with a deflection of approximately 3.1 inches. Then the next beam R2 was reinforced with five layers of flexural FRP sheets, similar to T-beam T2. At a load of 24.6 kips (109.4 kN), the CFRP reinforcement delaminated with tremendous energy release. The failure mode was mostly debonding failure between FRP and the concrete substrate. The FRP reinforcement provided a strength increase ratio of 2.0 over the control beam. The third beam to be tested was the rectangular beam R3 reinforced with the same five layers of flexural FRP reinforcement as the previous beam and fitted with FRP U-wraps to prevent premature debonding of the flexural FRP. The beam reached an ultimate load of 27.1 kips (120.5 kN) when the CFRP ruptured, as shown in Figure 2. The addition of the FRP U-wraps provided an additional increase in the flexural capacity by a ratio of 2.2 over the control beam. Figure 3 compares the load-deflection relationship of the three rectangular beams.

**Figure 1: Failure of beam T3 by FRP rupture.**

**Figure 2: Rupture of FRP on R3.**

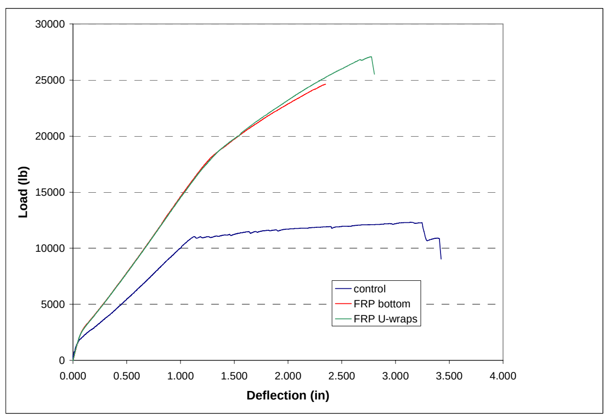



**Figure 3: Load-Deflection comparison of Rectangular beams.**

The last step in this phase of the research is to use the remaining T-beam specimen and reinforce it with the same five layers of flexural FRP. However, the FRP U-wraps will be applied in one layer to explore the sufficiency of one layer in preventing premature delamination of the flexural FRP.

### *3. Progress towards Objective 2*

After investigation of the MicroStrain wireless data acquisition system, a pre-stressed T-beam was used to model a bridge girder. The beam was instrumented with two strain gages on the bottom of the web at mid-span. One gage was used for the conventional data acquisition system and the other was used for the wireless system. Two accelerometers, one conventional and one wireless unit, were mounted on top of the flange at mid-span. A mobile vehicle was designed to simulate a vehicle driving across the bridge. The cart had a total weight of approximately 2100 lbf (9.350 kN). The cart was pulled across the beam using an electric wench having a pulling force capacity of 2000 lbf (9 kN). Figure 4 shows the setup of the T-beam with the mobile vehicle on it.

**Figure 4: Beam with mobile vehicle.**

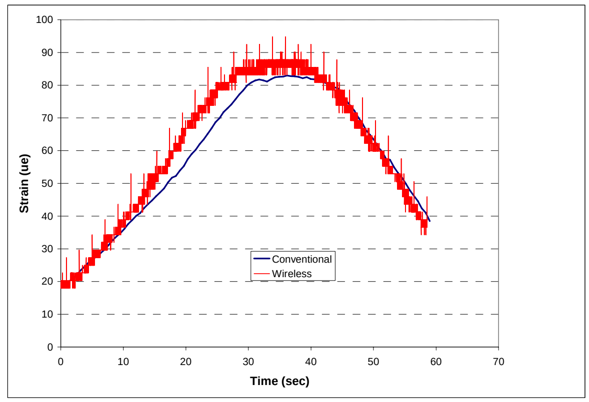



**Figure 5: Strain comparison of the two systems**

Acceleration tests were conducted first. The MicroStrain accelerometer was placed side-by-side with the conventional system. MicroStrain system had an excellent performance based on the test observations. The accelerations reached to an approximate level of ± 6.0 G (gravitational acceleration).

Following the acceleration tests, the strain feature of the MicroStrain system was tested against the conventional system. After completion of the tests, it was noticed that the maximum strain recorded by the wireless system was slightly higher than the conventional system and progressively got larger for each successive test. To overcome this, triggers had to be created in the MicroStrain software to allow the excitation to warm up then sense when the cart is applied to the beam and start data acquisition. After testing the trigger, the data was close to the conventional system. Figure 5 shows the strain recorded by the two systems.

The last step in this phase of the research is to perform a fast Fourier transform on the acceleration data. Since the conventional accelerometer system was not accurate enough to generate a comparison of the two systems, the Fast Fourier Transform (FFT)will be used to analyze the data.

**e) Advanced Modeling of Interfaces between Asphalt Concrete Layers and of Permanent Deformation in Subgrade Soils.**

Principal Investigators: Perić and Najjar

Theme: Advanced Modeling of Pavement and Subgrade Systems

Budget: $100,000

Project Timeframe: May 01, 2006 to May 31, 2008

*1. Background*

Dr. Dunja Perić became the Principal Investigator on this project on August 12, 2007, due to the departure of the previous PI (Dr. S. Romanoschi) from Kansas State University. Dr. Romanoschi had encountered some initial difficulties with recruiting graduate students. After an extensive eight-month search, he located two masters-level students, Maurice Wheat and Tito Nyamuhokya. While both of these students started working on the project in January 2007, only Wheat continued to work on the project after Dr. Romanoschi's departure; Nyamuhokya left with Dr. Romanoschi.

*2. Introduction*

For the purpose of reporting, the project is herein divided in two parts: I) advanced modeling of interfaces between asphalt concrete layers, and II) advanced modeling of permanent deformation in subgrade soils. Two students were hired to work on the project, Maurice had been engaged in testing asphalt specimens and Tito's work was related to testing soil specimens. Due to Tito's departure we are in the process of enrolling and hiring another graduate student.

*3. Progress on Part I of the Project*

The progress made on the tasks specified in the original proposal is tabulated in Table 1 for both parts: I and II. A literature search and review has now been completed for Part I. In addition, design and manufacturing of a special attachment for the IPC testing machine, which will enable testing of asphalt interfaces subjected to pulsating loads has also been completed.

Furthermore, a preparation of asphalt samples for laboratory testing has also been completed. To this end, Shilling Asphalt Company from Manhattan, Kansas made an approximately 20 foot section of about 4 inches thick coarse asphalt mix and another 15 foot of fine asphalt mix, also 4 inches thick. Next, tack coat was applied in the four different amounts: 1) no tack, 2) 11 grams/square foot, 3) 21 gram/square foot, and 4) 32 grams/square foot. Subsequently, next lift of asphalt was placed comprising 10 feet of fine mix and 10 feet of coarse mix. This procedure produced the following interface configurations: coarse on coarse, coarse on fine, and fine on fine (Figure 1). After setting in for few days, 4 inch diameter core samples have been taken for laboratory testing (Figure 2), which is scheduled to begin in the immediate future. In addition to four different tack coats and three different interfaces, each interface is to be loaded under two inclinations and each test is to be repeated once. Final number of tests will be verified with Dr. Romanoschi. It is anticipated that the testing will be completed some time in October. As test results become available, the data analysis will evolve.

Finally, Maurice has completed 70% of reporting. The present version of his M.S. thesis report contains completed chapters: 1) introduction, scope/objectives, 2) literature review, 3) methodology and sample preparation, and references. It is anticipated that Maurice's M.S. thesis report will be completed in December 2007 and final project report for Part I, will be available in January 2008.

Table 1: Progress on Tasks. The project is divided into two parts: modeling of interfaces, and II) modeling of permanent deformation in subgrade soils

| **Task** | | **Percent Completed** | |
|---|---|---|---|
| | | **Part I** | **Part II** |
| Literature Search | | 100% | 50% |
| Laboratory Experiments | Equipment Modifications | 100% | 90% |
| | Sample Preparation | 100% | 0% |
| | Testing | 0% | 0% |
| Analytical Modeling | | 10% | 10% |
| Reporting | | 70% | 0% |

**Progress on Part II of the Project**

Dr. Romanoschi contributed to the literature search while writing the proposal, while Dr. Perić performed some additional literature search on the related topics since Dr. Romanoschi departure. Dr. Romanoschi gave us a brief overview of the status of the project immediately prior to his departure. According to him, a triaxial cell has been modified to enable soil testing under simultaneously pulsating vertical and horizontal stresses, and it should be ready for testing.

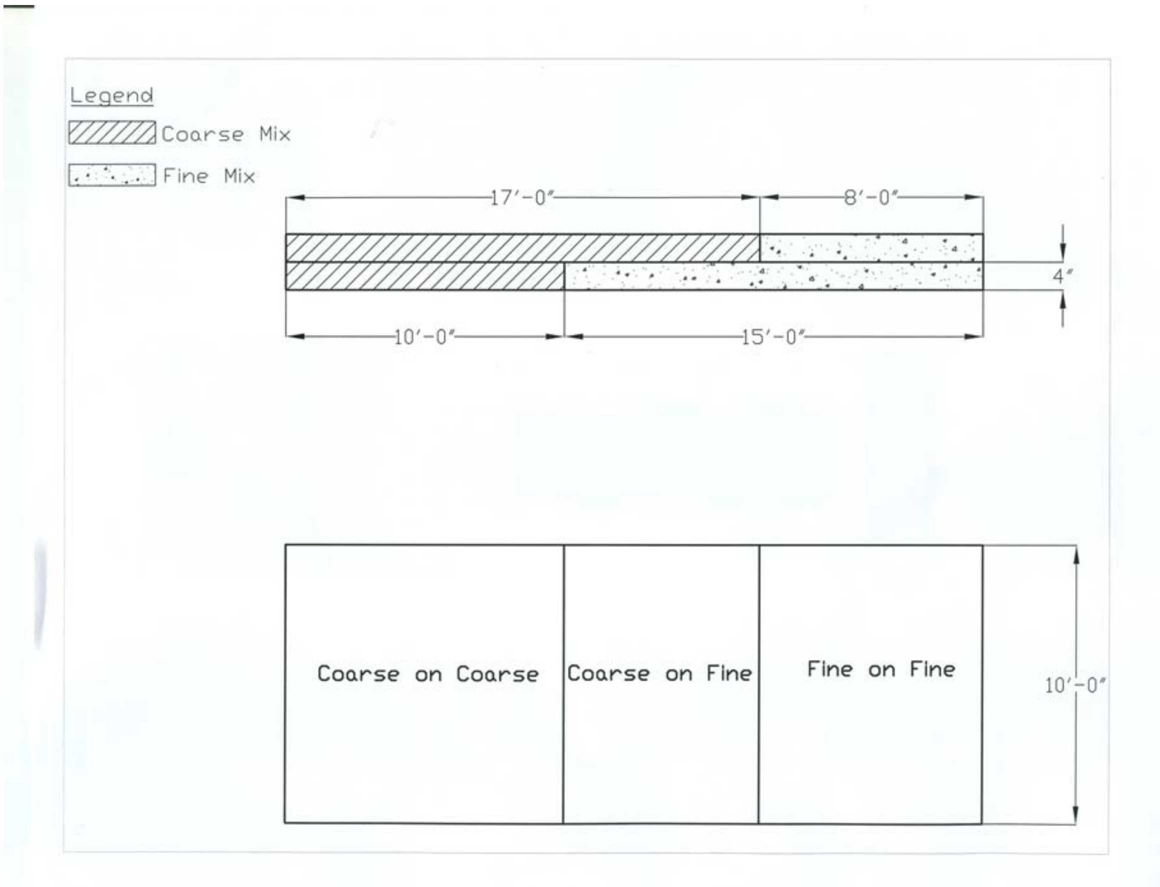



Figure 1: The layout of the asphalt pad constructed by Shilling Asphalt Company near CISL

Figure 2: The core samples after being removed from the pavement

Tito, who was supported from this project worked on the modification and in the process became familiar with the IPC apparatus. It is because Tito left and we currently have no graduate student working on Part II of the project that we have not been able to test and verify the functioning of the modified triaxial cell, which is to be used inside of the IPC testing machine in the asphalt lab. Consequently, no sample preparation, testing or reporting has been done on Part II of the project.

*4. Project Status*

It is anticipated that the project will generate one M.S. report in December 2007, and will partially contribute to one Ph.D. thesis. It is also anticipated that the project will lead directly to few refereed journal publications.

*5. PI's report of progress:*

| | |
|---|---|
| Project within budget? | **Yes** |
| Changes in project description? | **No** |

**Problems encountered (current or anticipated):**

A graduate student who has been trained and paid to work with the designated laboratory equipment left KSU with Dr. Romanoschi. A new graduate student (Shahin Nayyeri Amiri) has been located in Turkey. Shahin has been accepted for enrollment into Ph.D. program at KSU. We are presently in the process of issuing the documents needed for the student to obtain a visa to enter U.S. We are hoping that the student will be able to arrive to Manhattan and start to work on the project in January 2008.

*6. Significant products this period (reports, journal articles, proceedings, etc.):*

An M.S. report partially completed and in progress.

**f) Ensuring Longevity of Rural Highway Pavements Using Pavement Preservation Concepts.**

Principal Investigators: Hossain and Cai

Theme: Infrastructure Preservation / Renovation

Budget: $100,000

Funds Expended (03/31/07): $0

The objective of this part of this project is to develop a chip seal design based on Hamburg wheel load tester results. The study will be based on actual construction projects. Good progress has been made in this project in this quarter. The Kansas Department of Transportation (KDOT) has helped KSU to get cores from a number of chip seal and other thin surface treatment projects. The KDOT performance data base has been handed over to KSU for a historical assessment of chip seal performance. The testing will begin this Fall and the data analysis will continue through next Spring and Summer.

**g) Development of Efficient Asset Management Practices for Transportation Infrastructure in Rural Communities.**

Principal Investigators: Najjar, Dyssanayake, and Esmaeily

Theme: Infrastructure Preservation / Renovation

Budget: $75,000

This project has is suffering significant delays due to the recruitment of appropriate graduate students to complete the project objectives as well as the departure of Dr. Stefan Romanoschi. Dr. Romanoschi departed K-State in August, which caused further delays in the project. However, after an extensive, eight-month search, Kevin Friedrichs, has begun to make significant progress on the project.

| Task | Percent Completed |
|---|---|
| Literature Search | 80% |
| Field Surveys | 60% |
| Evaluation of Current Practice in Relation to the State of the Art | 50% |
| Reporting | 20% |

**PI's report of progress:**

Project within budget? **Yes**

Changes in project description? **No**

**Problems encountered (current or anticipated):** The MS student (Kevin Friedrichs) started working on this project in early January 2007. It took 8 months to recruit a graduate student for this project.

**Significant products this period (reports, journal articles, proceedings, etc.): None**