UTC RESEARCH PROJECT DESCRIPTION

PROJECT NUMBER: 05109

PROJECT TITLE: Risk-Based Bridge Inspection and Maintenance

PRINCIPAL INVESTIGATORS:
Kenneth J. Fridley, Ph.D.
Professor and Head
Department of Civil & Environmental Engineering
The University of Alabama, Tuscaloosa, AL  35487-0205
T:  205-348-3585   F:  205-348-0783   E:  kfridley@coe.eng.ua.edu

David P. Hale, Ph.D.
Director
Aging Infrastructure Systems Center of Excellence & MIS Programs
The University of Alabama, Tuscaloosa AL  35487-0226
T:  205-348-5525   F:  205-348-0560   E:  dhale@cba.ua.edu

PROJECT OBJECTIVE:
To effectively manage the increasing demand on bridge inspection and maintenance resources, this research will investigate risk-based (or reliability-based) techniques to more effectively utilize bridge inspection data by integrating it with structural system response, performance and risk criteria. The research brings together the expertise and knowledge gained through two separate but related efforts to develop a foundation for risk-based decision making related to bridge inspection, rating, and maintenance.

PROJECT ABSTRACT:
The proposed research is an extension and integration of two research endeavors undertaken independently by the principal investigators. K. Fridley, with support from the Washington State Department of Transportation, explored the use of probabilistic (reliability) methods, specifically fragility techniques, as a foundation for assessing seismic retrofit strategies for WashDOT standard bridge designs. In a parallel ongoing effort, D. Hale (Management Information Systems and Aging Infrastructure Systems Center of Excellence) is working with the Alabama Department of Transportation (ALDOT) to investigate the use of statistical regression modeling techniques in quality control to define historic associations among bridge component deterioration metrics for performance, safety, and impact on financial planning. Fridley’s efforts have been a “bottom up” structural response and performance approach to evaluation of repair techniques, and Hale has approached the similar issue from a more “global” information management/decision science approach. This research begins the important endeavor of melding the expertise and knowledge gained through these separate but related efforts to develop a comprehensive, risk-based decision making foundation for bridge inspection, rating, and maintenance. Ultimately, such an approach will allow bridge officials a robust, quantified method for inspecting, maintaining and upgrading standard bridges.
PROJECT TASK DESCRIPTIONS
1) Work with ALDOT’s Maintenance Bureau to define performance measures, and classes of bridges to explore.
2) Develop a comprehensive, finite-element based, stochastic performance model.
3) Create baseline for evaluation.
4) Conduct integrated numerical analysis, perform fragility analysis, and validate model(s).
5) Present results to ALDOT project advisory committee to explaining meaning, and reconcile areas of counter intuitive/theory issues.
6) Develop technical presentations.
7) Develop final report and journal articles.

MILESTONES AND DATES:
Task 1: June 2005
Task 2: Jun-Dec
Task 3: Jun-Aug
Task 4: Jan-Mar 2006
Task 5: Mar
Task 6: Apr
Task 6: Mar – May 2006

BUDGET:
One-year project: UTCA funds $54,000; UA $54,000 total budget $108,000.

STUDENT INVOLVEMENT:
This is a continuation of a series of projects conducted with the ALDOT Maintenance Bureau entailing significant student involvement. Specifically this project extends a model developed as part of a multidisciplinary dissertation program that combines Civil Engineering (CE), management science (MS), and information systems (IS). This research will extend this approach of high student involvement. One graduate research assistant will be fully engaged in the research effort. S/he will be under the guidance of both Fridley and Hale. The GRA will not be working alone. The student will interact extensively with students in both MIS and CE, drawing heavily from both. The research will be used by the student as the basis for his/her thesis.

Additional students will be involved through seminar presentations involving graduate students from CE, MS, and IS. In addition, the model building and subsequent assessment will be used as exercises for students in their analytical coursework, and a first-year doctoral student will be assigned to shadow the project to gain initial transportation field project experience. Results from this work will be added to ALDOT’s Executive Bridge Portal. Consequently 10 additional IS students will ultimately be involved with the project.

TECHNOLOGY TRANSFER ACTIVITIES:
The results of the research will be the basis for at least one technical presentation at a national conference (e.g., TRB, SEI, etc.), a proposal will be made to the UTCA annual research symposium, and a series of presentations will be made throughout the project to ALDOT staff. Also, and more importantly, the research will result in at least one peer-reviewed journal publication (e.g., J. of Structural Engineering, J. of Bridge Engineering, etc.). Finally, both
Fridley and Hale integrate their teaching efforts. The results of this research will be integrated into courses in both MIS and CE, and will form the prototype for additional collaborative multidiscipline research activities involving the Colleges of Engineering and Business.

RELATIONSHIP TO OTHER RESEARCH PROJECTS:
This project is part of a portfolio of initiatives focused on improving performance and safety of the nation’s infrastructure through deliberate, methodical and organized model based tool sets. Related projects include UTCA 05404 – “Development of a Fixed Asset System for Bridges,” UTCA 04111 - “Executive Bridge Management System,” UTCA 03419 - “Transportation Planning Network Data-Analysis-Visualization,” UTCA 03112 - “Forecast Bridge Decay/Maintenance” and WashDOT “Reliability-based seismic retrofit of bridge columns.”

POTENTIAL BENEFITS OF THE PROJECT:
To aid in this effort, the researchers have enlisted the cooperation of the Alabama Department of Transportation (ALDOT). ALDOT is in the midst of evaluating its Bridge Management System.

This project will create better forecasts by combining historical condition data with dynamic modeling techniques. Results from this project will enable state DOTs, such as ALDOT, to more accurately forecast the conditions of the state’s bridges and more effectively examine construction alternatives and maintenance resources. The impact of this research is likely to cascade across organizational boundaries to include DOT bureaus of materials and test, bridges, construction, design, maintenance, and planning. This work explicitly addresses the UTCA theme of Management and Safety of Transportations Systems. Without improved forecasts, less than optimal decisions are often made.

TRB KEYWORDS:
asset management, bridges; dynamic modeling; forecasting; inspection; maintenance; performance; reliability; repair; safety