I. RESEARCH PROJECT TITLE

Innovative Systems of FRP Bridge Deck Panels with Crash-Worthy Guardrails

II. RESEARCH PROBLEM STATEMENT

Several bridges are constructed with cast-in-place concrete on steel girders, and many of these concrete decks have severely deteriorated with exposed and rusted rebar as a result of exposure to deicing salt. The steel girders and the substructure on many of these bridges are generally still in good condition. Under the sponsorship of the Kansas Department of Transportation (KDOT) and following several years of R&D, the design, implementation, and testing of an alternative to concrete deck replacement have been completed. The system consists of Fiber Reinforced Polymer (FRP) honeycomb sandwich panels with either proper steel post or precast concrete guardrails. Although FRP deck panels were already designed, tested, and considered earlier, they could not be used until acceptable bridge railing systems has been completed in summer 2009.

A system of precast, vertical-faced, concrete barriers fastened to the deck panels by a specifically designed attachment using anchor rods, plate washers, and nuts, was tested at the Midwest Roadside Safety Facility (MwRSF) in Lincoln, Nebraska. The system met the Test Level 3 (TL-3) evaluation criteria specified in the *Manual for Assessing Safety Hardware* (MASH). A system of steel thrie beams/rails with steel posts, which was previously crash-tested successfully in 2005 and recommended for FHWA approval in accordance with the test Level 4 (TL-4) criteria of NCHRP Report No. 350, presents another viable option for guardrails.

III. RESEARCH OBJECTIVES

The system is now fully implemented and ready to be used on temporary/detour bridges, or as permanent replacement to concrete decks. It is scheduled to be used in three Kansas bridges in the near future, one of which is planed in Pottawatomie County as early as next summer. Although the system had been officially approved for use in practice, no special design standards or guidelines are available specifically for FRP decks. Development of design formulas such as shear capacity, lateral wheel load distribution, and long-term effects of temperature, moisture, and fatigue will lead to more economical and safer designs. Also further research is needed for connection details, fabrication and/or construction modifications, and additional testing of the deck system under simulated service load conditions.

IV. ESTIMATE OF FUNDING AND RESEARCH PERIOD

Estimated level of funding: $ 25,000
Research Period: 18 months from the beginning of the project funding (as early as Spring 2010).
One MS student will be involved in this research, with financial support for the student sought from other sources.

V. URGENCY AND PAYOFF POTENTIAL

Some bridges were originally constructed with light-weight concrete decks that got deteriorated to the point where they are no longer functional. Since light weight concrete is no longer allowed in bridge decks, and the alternative open steel grating is not allowed either in Kansas, the only other option is to replace these entire bridges. When the substructure and girders are in good condition (which is often the case) using FRP panels will keep such bridges in service with a new deck at about half the cost of the bridge replacement. Repair/construction time will be days rather than weeks or months.

This activity is primarily in collaboration with the industry (BG Consultants). The promotion and application of such systems in practice can open the door for wide applications and a number of design/construction projects. At that time, DOT's and FHWA will be interested in developing design guidelines and a set of standards for the common use of such new techniques. Also the people involved are considering patenting the innovative system being developed which can be a source of loyalty and continuous funding.

VI. IMPLEMENTATION STRATEGY

FRP panels offer an economical replacement to concrete decks, as their 70-80% lighter weight allow higher live load while keeping the existing girders and substructure. Also the roadway can be made wider by increasing the overhang. Both features are much needed to accommodate increasingly heavier truck and/or larger framing equipment.

The advantage of such system is that it is also reusable such that, after a number of years (or weeks) of service, the system can be disassembled and used in different locations without affecting the integrity of the panels. It is most adequate for small span bridges such as those commonly used on County roads and rural areas in Kansas.

VII. PROJECT PERSONNEL

The primary and sole design firm in charge of designing bridges with FRP deck panels is BG Consultants of Manhattan, Kansas. The work in this activity is the continuation of collaboration between the faculty member and the bridge design engineer in that company. The principal investigator of this project will be Dr. Hani Melhem (P.E., Ph.D., F.ASCE, Professor of Structural Engineering) who has many years of experience in the area of structures analysis and design, and highway bridges. He has been the director of the Annual Bridge Workshop at Kansas State for over 16 years. One Graduate Research Assistant will work on this project, whose thesis would be focused on this study. Design engineers from BG Consultants will be involved in this project. The primary collaborator from the engineering firm will be Mr. Moni El-Aasar, Ph.D, P.E, vice-president, who has worked several years in bridge designs in general, and on the FRP panels application to bridges in particular.

VIII. SUBMISSION INFORMATION

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