I – Problem Statement Title (04-GS064)

Non-Destructive Evaluation of Fiber Reinforced Polymer (FRP) Composite Bridge Decks

II – Research Problem Statement

Question:

Can Caltrans use the process of real-time reverse X-Ray digital imaging or acoustic emission testing of composite bridge decks for maintenance deck inspections and post-earthquake damage assessments?

III – Objective

To develop effective non-destructive inspection methods using Acoustic Emission (AE) Testing or Reverse Geometry Digital X-Ray (RGX) imaging to evaluate the internal geometry of an FRP bridge decks to locate delaminations, damage or defects?

a) Use existing Schuyler Heim Bridge FRP test deck panels to develop AE characteristics/signature of damaged deck panels.
b) Use existing Schuyler Heim Bridge FRP test deck panels to detect internal damage of previously damaged and repaired panels using RGX (Reverse Digital X-Ray, DigiRay NDE equipment).
c) Locate damage using AE and RGX and repair damaged sections, examine repair using AE and RGX and follow up with structural tests to confirm repair.

IV – Background

Several Non-Destructive Evaluation (NDE) methods exist for evaluating composite structures, and extensive research has been conducted in the area of NDE of composite materials. Most research applies to aerospace structures such as thin laminates, shells, or thick continuous materials. However, due to the complex internal structure of and FRP pultruded composite deck, it is difficult to evaluate the internal structure. Most FRP bridge decks, have a hollow core with a top and bottom composite laminates, range in thickness form 5 to 18 inches, and have internal ribs and webs.

Caltrans currently has two bridges, which have FRP composite bridge decks; namely, the Kings Stormwater Bridge, and the Schuyler Heim Lift Bridge. The widely used method for inspecting FRP bridge decks is simply visual which can only reveal defect or damage on the surface. In addition, the wear surface provides an additional mask which can make it very difficult to detect a delamination between the core and composite face sheets. Also the wear surface makes it virtually impossible for conventional NDE methods such as UT and tap testing to evaluate the deck core.

If AE or RGX can provide an early detection of damage, then the FRP bridge decks and be repaired preventing further damage or bridge closer. Caltrans is the only DOT which has shown that an FRP composite bridge deck which has been severely damaged can be

repaired and its strength and stiffness be restored with simple repair procedures (J. Gutierrez, Repair Procedure and Testing of a FRP Composite Bridge Deck, 10th US-Japan Conference on Composite Materials, Stanford University, 2002). This research would further advance the research on FRP Deck repair and effective inspection methods.

V –Statement of Urgency and Benefits

A. Support of the Department's Mission/Goals

(Improving Mobility: Safety and Reliability) These goals are realized by the potential to keeping open bridges with composite bridge decks while undergoing repairs of early-detected damage. By developing an effective non-destructive inspection method, early detected damage to a composite bridge deck can be located and the bridge deck can be repaired while keeping the bridge open to traffic. Structures Maintenance has identified the future need to replace steel grate bridge decks with composite decks, and more of these decks will be installed in the future. These inspection methods/tools would facilitate inspection of composite bridge decks. The benefit of this research is to provide a reliable and effective inspection method for early detection of internal damage of an FRP bridge deck core. With these results and previous Caltrans research, repairs can be performed to restore the FRP bridge deck to its original structural capacity.

B. Return on Investment:

The return on the investment of this research or the benefit to cost ratio is quite good based upon a Schuyler Heim deck replacement and installation cost of $450,000, not to mention much more potential savings due to early damage detection of other composite bridge decks. Estimated cost to maintain, rehabilitate or replace bridges is $15 million/year. If increased use of composite decks reduce this cost by even 1% annually, annual savings would be $150,000 per/year. Also, a substantial cost savings is realized by the traveling motorist by keeping the bridge open to traffic while necessary repairs are performed after damage is detected.

VI – Related Research

J. Gutierrez, Repair Procedure and Testing of a FRP Composite Bridge Deck, 10th US-Japan Conference on Composite Materials, Stanford University, 2002.

VII – Deployment Potential

Inspection procedure which can be use to effectively evaluate the internal core of an FRP bridge deck.