FY 07/08 Research Initial Scope of Work

I. Project Title: **S081**

Validation of Rehabilitation Strategies to Extend the Service Life of Concrete Bridge Decks

II. Background:

Considerable research has been conducted on rapid deterioration of bridge decks due to environmental conditions and deck protection systems. However, when these protection systems begin to break down and the deck is in need of complete restoration, widely varying results have been obtained from the strategies employed. With our current state of knowledge, it is difficult to predict the effectiveness, durability, and life of deck rehabilitation strategies currently in use in California.

One known need for research is on the effectiveness of polyester overlays for deck rehabilitation. This strategy has been used in California over the last 10 to 15 years to repair areas of deteriorated deck. There is some evidence that this may not always be an effective long term rehabilitation strategy. Previous research has shown that high molecular weight methacrylate (HMWM) has the ability to partially restore the structural function of cracked bridge decks. What is not clear however is how long this treatment is effective or at what stage of cracking is the appropriate time to apply HMWM.

III. Project Problem Statement:

Currently, the standard service life of a highway bridge deck is considered to be 40 years or less, while the standard design life for a highway bridge is 75 years. Deck replacement options, particularly for post-tensioned box girders commonly used in California, have been difficult, unreliable and expensive. Preserving decks in good condition for as long as possible by applying timely and sound rehabilitation strategies will provide the extended service life needed in our bridge decks making deck replacement unnecessary.

Deck rehabilitation strategies utilized in California to extend the life of the deck range from applying HMWM to fill deck cracks, to removal of the top several inches of deck concrete and recasting the partial deck section with PCC or polyester concrete, or in some cases to placing a new deck constructed on top of the old deck.

These strategies have been both successful in extending the service life of the deck and have in other cases failed rather rapidly. There are numerous variables that may contribute to early failure of a rehabilitated bridge deck. These variables include environmental conditions, construction practices, as well as the physical design properties of the deck. Through this research, many of the variables may be eliminated and a side by side comparison of strategies and timing can be better evaluated. Are current bridge deck rehabilitation and preservation strategies

effective in extending the service life of highway bridge decks in the State of California?

IV. Objective:

The objective of this research proposal project is:

1. Research the effectiveness of the current Caltrans practice of partial depth deck replacements using polyester concrete and PCC to upgrade deteriorated decks. This research would also explore the value of thin polyester overlays on top of cracked decks without removal of cover concrete. More specifically this should include:
    a) load cycle vs. deterioration data for optimizing the timing of rehabilitation strategies;
    b) analysis of parameters that affect the success of each rehabilitation strategy; and
    c) evaluation of the effectiveness of the application of methacrylate on strength and durability of cracked bridge decks under rolling loads.

V. Description of Work and Expected Deliverables:

Research should include:

⇒ Laboratory testing to failure of deck slab panels before and after rehabilitation of the sections using rolling loads.

⇒ Laboratory testing of cracked slabs, at various levels of distress, treated with HMWM using rolling loads. Quantification of the permeability, strength increase and life expectancy of permeability and strength increases should be determined. The appropriate timing of the application measured in terms of crack size and density should be determined.

⇒ Develop a numeric analysis of the rehabilitated deck sections using both PCC and polyester concrete as the restorative material.

Deliverables will be:

- An evaluation and report on California's strategies to rehabilitate and extend the service life of concrete bridge decks.
- A report on the appropriate timing, frequency, and benefits of applying HMWM to bridge decks in California
- A copy of relevant research results to support the report, recommendations for changes in rehabilitation strategies, and recommendations for further research.

VI. Estimate of Duration:

36 Months

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VII. Related Research:

From "NCHRP Synthesis 333, Concrete Bridge Deck Performance, A Synthesis of Highway Practice", 2004, Appendix D, Research in Progress:
Arkansas: Evaluation of Bridge Deck Sealants
Delaware: Monitoring High-Performance Concrete Bridge Deck Projects
Illinois: Evaluation of Low-Permeability Concrete Mixes for Bridge Decks
Indiana: Field Investigations of a Concrete Deck Designed by the Empirical Method Long-Term Durability of Rapid-Set Cement-Based Materials Bridge Deck Cracking in Various Superstructure Systems
Kansas: Construction of Crack-Free Bridge Decks (Pooled study with other states)
Massachusetts: Performance evaluation and economic analysis of combinations of Durability Enhancing Admixtures for Concrete for Bridge Applications in the Northeast
Minnesota: Trial Placements of Silica Fume Concrete
New Jersey: High-Performance Concrete Mix Designs
New York: Concrete Deck Material Properties
North Dakota: Performance Evaluation and Monitoring of Low-Permeability Concrete Bridge Decks
Ohio: Deck Cracking
Texas: Methods to Control Drying Shrinkage Cracks in Concrete Bridge Decks
Virginia: Concrete Shrinkage and Creep Service Life of Epoxy-Coated Reinforcement Bridge Deck Service Life Prediction End-result Specifications Use of Stainless Steel Clad Reinforcement Fiber-Reinforced Concrete Lightweight High-Performance Concrete Electro-Chemical Chloride Extraction
Alberta: Analysis of 25 Years of Deck Testing and Rehabilitation Methods
Quebec: Ternary Blend Cements with Different Combinations of Supplemental Materials, Matsui 1997; Perdikaris & Beim, 1988; Kumar & GangaRao, 1998; Hawkins, 1974; Bachelor and Hewitt 1976; Keiichero et al, 1986.

VIII. Deployment Potential:

Concrete box girder bridges with their integral decks are the predominant bridge type in California. Their decks cannot be easily replaced, increasing the importance of preservation activities. Study should provide recommended changes to rehabilitation strategies.

IX. Date: July 18, 2007