CALTRANS PROBLEM STATEMENT
FOR
POTENTIAL NATIONAL INTEREST

I. PROBLEM STATEMENT TITLE

Reduce Cracking in Bridge Decks through the use of Hybrid Fiber Reinforced Concrete

II. RESEARCH PROBLEM STATEMENT

How can we deploy a crack resistant fiber reinforced concrete into practice?

Both environmental and traffic loading cause the concrete to crack which accelerates the deterioration process by allowing agents such as water and chlorides to enter the concrete. Therefore, deterioration of bridge decks cannot be reduced unless crack formation is controlled and minimized. The Department has successfully developed a hybrid fiber reinforced concrete composite (HyFRC) for use in bridge approach slabs. Its design was based on mechanical performance criteria associated with crack resistance and enhanced post crack flexural stiffness. In this HyFRC, microfibers delay crack initiation of microcracks (due to their small diameter) and macrofibers reduce the formation of macrocracks and their crack opening displacements. These HyFRC composites were also tested for durability by exposing them to severe environmental conditions such as freezing and thawing cycles, corrosion, and scaling tests. The composites performed extremely well. In order for the HyFRC to be utilized for field applications the workability of the HyFRC needs to be adjusted for cast in place applications.

III. OBJECTIVE

The objective of this research is to adjust the workability of the HyFRC mix for cast-in-place applications and then develop a procedure to implement a crack resistant hybrid fiber reinforced concrete composite (total volume fraction of fibers is 1.2%) into practice.

IV. BACKGROUND

The FHWA High Performance Concrete (HPC) Technology Delivery Team survey results reveal that cracking of bridge decks is ranked among the highest distress of bridge decks of all DOTs in U.S (despite use of HPC). The NCHRP project on deck cracking concludes that for most bridges, concrete properties affect cracking more than design issues. Unfortunately, low water-cement ratio concrete due to its high heat of hydration and low creep characteristics are more susceptible to cracking. This is why newly constructed decks of high quality, low water-cement ratio concretes that were cured with good moist curing procedures still exhibit cracking. What is required to prevent these cracks is a crack resistant

concrete. A proposal to use HyFRC composite for bridge approach slabs will prevent these cracks.

V. ESTIMATE OF FUNDING

Estimated Funding: $350,000

VI. DURATION OF RESEARCH

Duration of Research: 24 months

V1I. Statement of Urgency, Benefits, and Expected Return on Investment

The Federal Highway administration conducted a survey on performance of bridge decks. Cracking was cited as the most dominant distress of bridge decks. Addressing the cracking problem is of utmost importance. Minimizing crack formations at early ages and controlling crack propagation and crack width at later ages will reduce deterioration of bridge decks and hence minimize repair and replacement efforts and disruption to traffic flow. The Transportation Research Board has determined that by increasing the durability of America's roads and bridges by *one percent*, up to *$30 billion* can be saved over a 20-year period. Controlling both micro- and macrocrack formations in concrete structures through the use of HyFRC will enhance their durability by far more than just 1%.

VIII. RELATED RESEARCH

- This project is a continuation of Caltrans Project "Use of Fiber reinforced concrete for bridge approach slabs" being researched by Prof. C.P. Ostertag at UC Berkeley. The work proposed in this problem statement are the final steps required for deployment of this material into practice.
- NCHRP project on deck cracking concludes that for most bridges, concrete properties affect cracking more than design issues.
- FHWA High Performance Concrete (HPC) Technology Delivery Team survey results reveal that cracking of bridge decks is ranked among the highest distress of bridge decks of all DOTs in U.S (despite use of HPC).

IX. DEPLOYMENT POTENTIAL

We are seeking financial support for the final steps that are necessary for deployment of HyFRC into practice such as workability adjustments and full-scale laboratory testing to provide the community a truly crack resistant and durable material for bridge decks. The need for repair and replacement of bridge decks will be reduced considerably because HyFRC controls crack initiation and propagation of microcracks at onset before they coalesce into dominant macrocracks. Resisting microcracks from propagating and thereby delaying macrocrack formation is a necessary requirement for durability enhancement in bridge decks and can be achieved in these hybrid composites at relatively low fiber volume fraction.

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Please contact the Caltrans member of your committee, sub committee, or task force to express interest or contact Wes Lum at Caltrans (wes.lum@dot.ca.gov).