Transportation Research Board

AFN 10: Basic Research and Emerging Technologies in Concrete

I. PREFACE

An important role of the Transportation Research Board (TRB) is to foster and nurture research that addresses problems facing the transportation community. In support of this agenda, this committee will identify potential problems related to concrete materials, and develop research needs statement within the committee's scope of coverage that is robust, up-to-date, and reflects the committee's research agenda.

II. PROBLEM TITLE

"Reliable prediction of service life model of HPC bridge decks"

III. RESEARCH PROBLEM STATEMENT AND BACKGROUND

The chloride induced corrosion of steel reinforcement embedded in concrete is a significant issue that threatens anticipated service life of concrete structures. Until recently, such models have concentrated on estimation of corrosion initiation. Very little research has been done for computation of corrosion propagation time for High Performance Concrete (HPC). In addition, there are some unresolved questions regarding probabilistic modeling of corrosion propagation time. The increased electrical resistivity of concrete with supplementary cementing materials has the potential to reduce corrosion rate after active corrosion initiation has started. Over the life of a bridge deck and other highway structures, improved serviceability performance is achieved with the use of HPC by delaying the cracking, spalling of concrete cover due to chloride induced corrosion propagation and unacceptable condition of the reinforced concrete structure. The inclusion of the corrosion propagation time of HPC concrete in service life model becomes important in order to provide accurate methodology for estimation of service life and life cycle cost of nation's infrastructure.

IV. RESEARCH PROBLEM OBJECTIVE

This research will indicate the road map to formulation of accurate service life model of HPC bridge decks with respect to chloride ingress in harsh chloride environments. Evaluation of the propagation period would allow comparison of the effect of several HPC mixture designs on overall durability performance of the concrete structures. Concrete resistance of supplementary cementitious materials against chloride penetration retracts the corrosion initiation and slows down active corrosion propagation. Electrical resistivity data of HPC mixture designs would be an essential added component in service life model and this model is aimed to provide first insight into the beneficial effect of High Performance Concrete (HPC) mixtures in delaying corrosion induced cracking. Incorporation of the service life into public infrastructure requires advanced knowledge of degradation mechanisms, construction materials, reliability assessment, quality control, and engineering practices. Despite the obvious need to design concrete structures with a long life, user friendly tools and aids to achieve this goal are still under the process of development.

V. POTENTIAL BENEFITS AND IMPLEMENTATION

There is a growing demand in the engineering community and society for a function-oriented approach to the design of infrastructure, which would reflect the required level of reliability, service life, optimization of the total cost of construction and environmental impact. Attention will be mostly paid to Performance-Based Design as Assessment of Reliability with regard to Functional Characteristics. This work can be implemented for three reasons:

1. Most of the existing service life model does not include electrical resistivity data of HPC mixture designs and allows deterministic modeling of corrosion propagation time. Since there is a large scatter and variation in input parameters it is necessary to take into account randomness of input parameters in service life model for probabilistic approach.
2. Ternary based HPC mixtures have large effects in reduction of active corrosion by reducing corrosion current density and increasing remaining service life of concrete structures. Electrical resistivity of HPC mixtures can provide an accurate prediction of degradation mechanisms due to corrosion propagation of bridge decks in chloride laden environments.
3. Quality estimation of degradation processes allows industry professionals to better design the reinforced concrete structural systems so that they are resistant to long-term environmental effects and loading. This research effort will benefit several DOT's and FHWA by accurate prediction of service life and reducing long term maintenance costs of bridge decks.

VI. ESTIMATE OF PROBLEM FUNDING AND RESEARCH PERIOD

Long term electrical resistivity testing is needed for HPC mixtures to obtain time dependent variation of resistivity and its effect on the corrosion propagation rate of reinforcing steel. The research effort is anticipated to cost $200,000 over 2 years ($100,000 each year).

VII. PERSON(S) DEVELOPING THE PROBLEM

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