Reliability-based Modeling of Chloride-induced Corrosion in Reinforced Concrete Bridges

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1. Chloride induced corrosion is a prominent source of deterioration in reinforced concrete structures. The objective of my project is to develop a model for improved prediction of life-time performance of bridges in chloride laden environments. This can be achieved through refinement of models and parameters currently employed in corrosion modeling, using laboratory tests and microscopic investigation of concrete samples, along with statistical analyses for determining the distribution of key parameters in the field. The updated database is then incorporated into the target reliability-based model.

In traditional bridge management, information is mainly obtained through visual inspection of the structural condition, and decision is made based on the experience and judgment of professionals in charge. One of the most severe limitations resulting from this subjective approach is that bridge reliability is not directly incorporated into the decision making, as the ability of bridge owners to predict the extent of future deteriorations is very limited. Also, most of decisions in the bridge management process are made under the condition of uncertainty. Using reliability-based methods, different sources of uncertainty can be incorporated into the final performance prediction system. Coupled with the reliability index, these will provide a rational indicator of structural condition.

Bridges are essential links in transportation networks and to keep them safe and functional at all times is of great economical and social importance. Currently, many countries are facing difficulties to deal with the large number of deteriorated infrastructures. In the United States, more than 25% of bridges have been classified as deficient, and the required budget for immediate repair of them has been estimated to be in the order of 140 billion dollars, in 2006. In European countries, the annual expenditure of bridge maintenance reaches hundreds of million euros. Given that national road authorities are often working with limited funds, maintaining a balance between the increasing costs of repair and the available budgets is a challenging task, and to do this efficiently requires a systematic and uniform framework for inspection and decision making. The objective of current study, and its contribution from the economical point of view, is to optimize the intervals and extents of repair actions, in order to finally minimize the maintenance costs.

The life-time prediction model proposed for deterioration of structures exposed to chloride-induced corrosion, consists of two stages. An initiation stage, which is the duration of time it takes for chloride ions to penetrate concrete and depassivate the protective layer covering reinforcement. And propagation stage, during which active corrosion takes place, leading to formation of cracks in concrete cover. The focus of current study is mainly on refinement of the parameters involved in initiation stage. Once the initiation stage has been incorporated into the target model, further research can be carried out for refining the second stage of deterioration process, which is in turn, dependent on several random parameters to be addressed and future studies.

2. The high regard of Marie Curie Actions for involving industry in problem identification and planning the overall scope of research, indicates that the importance of transferring knowledge between private sector and academy, has been fully realized; enabling production of more efficient, pragmatic solutions for a realistically identified problem. The quality of research and career progress can also be assured through the involvement of prestigious European institutions; and also regular training and assessment events, enhancing the researchers' knowledge and skills. While the relatively large number of expected publications from each action, is a further encouraging factor, the collaboration itself, will make a positive impact on the achievements of fellows.