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Project Title: Corrosion mechanism of steel bars in nano-modified cement-based materials

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Project Outline:

Reinforced concrete is one of the most wildly used structural engineering materials in the world. The deterioration of reinforced concrete structures caused by the chloride-induced rebar corrosion is a major problem attracting world-wild attention nowadays. In order to mitigate the corrosion of steel bars in concrete, large amount of work has been done by the researchers. Many corrosion protection methods have been developed, such as the use of corrosion inhibitors, corrosion resistant steel bars, surface coatings and electrochemical prevention methods. These methods are recognized as traditional technologies for corrosion protection of rebars. All of the mentioned methods have certain limitations during application.

Recently, nano-scale cement based materials was reported as the next ground-breaking development for concrete structures. Many kinds of nano materials, nano-silica (NS), nano-alumina (NA), carbon nanotube (CNT), carbon nanofiber (CNF) etc., have been studied for possible application in concrete. These nano-materials with ultra-high specific area might exhibit a) nucleation effect, b) filling effect and c) bridging effect (for CNT and CNF) in concrete. They are also proved to be efficient to enhance the performance of concrete, including the mechanical properties, deformation performance and especially the durability by improving the hydration of cement and the microstructure of the concrete. These enhancements of concrete performance would be beneficial to the protection of the steel bars embedded in the concrete. In addition, the passivation process of the steel bars in concrete could be affected and the corrosion resistance of the passive film on the steel surface could be significantly improved by the addition of nano-silica in concrete according to our previous work to be published. Therefore, these nano materials might serve as effective admixtures in concrete for corrosion inhibition, and the application of nano-

materials would also be a potential novel corrosion-prevention method to extend the service life of concrete structures in aggressive environments. However, studies about the influence of nano materials on the corrosion of steel bars in concrete are rather rare.

Only a few researchers focused on the durability of the concrete matrix with the incorporation of nano materials, and several researchers studied the corrosion behavior of steel in concrete with nano materials. The corrosion resistance of the nano-modified concrete matrix has not been thoroughly studied, and the corrosion mechanism of steel bars in nano-modified concrete remains unknown. Therefore, a systematic study of the corrosion mechanism of steel in nano-modified cement based materials is in great need. In the present project, commonly used nano-materials will be selected, such as the nano-silica(NS), carbon nanotube (CNT) and carbon nanofiber (CNF). Four aspects of studies will be conducted, which would offer a systematic knowledge of the corrosion of steel bars in nano-modified cement based materials.

1) corrosion resistance (durability) of nano-modified cement-based materials.
2) passivation of steel bars in nano-modified materials.
3) determination of chloride threshold value (CTV) of steel bars.
4) monitoring of corrosion propagation of steel bars in nano-modified concrete.

Objectives:

The aim of this project is to understand the influence of the nano-materials on the corrosion of steel bars in concrete, revealing the corrosion mechanism of steel bars in nano-modified cement based materials. There will be great significance for understanding the application of nano materials in reinforced concrete and the behavior of steel reinforcement in high performance reinforced concrete.

Expected deliverables:

By the end of the project period, at least 2 journal papers will be submitted for publication/published.