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Work Theme A: Sustainable Infrastructure Development

A2: Localized corrosion in galvanized steel reinforcements in reinforced concrete structures

Project Title:

a) **"Corrosion Mechanisms and Prevention of High Performance Steel in Reinforced Concrete Structures"**

Principal Investigator: **Prof. C.S. POON (CEE)**

Project Team Members: **Dr. W.J. Zhu; Mr. H.B. Zheng**

Progress Report:

Study on corrosion rate and mechanism

As supplementary cementitious materials (SCMs) are widely used in concrete structures, the concrete pore solution may vary in composition as well as in pH value. In this work, the passivation process and the protective properties of the passive layers on the galvanized steel bars were studied in simulated concrete pore solutions with various compositions mimicking the incorporation of SCMs. The results showed that a continuous protective layer could be formed in pore solutions with a high concentration of Ca^{2+} at a pH value of 12.5, and pore solutions with either KOH or NaOH at a pH value of 13.15. The passive film formed in the saturated $Ca(OH)_2$ solution showed better protective properties than that in other solutions. In the solutions with a lower concentration of Ca^{2+} at pH value of 12.5, there was no obvious corrosion process with hydrogen evolution, and no protective layer was formed on the galvanized steel surface.

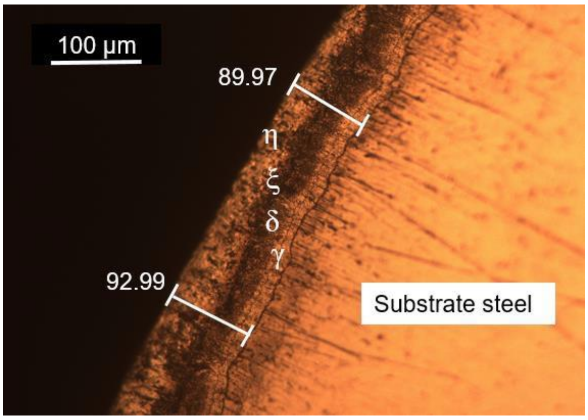


Fig. 1 Cross-section of the Hot-Dip Galvanized Steel bar observed by metalloscope. The specimen was firstly natal etched (2% nitric acid in ethanol) to reveal the four phases (η, ξ, δ and γ phase) in the galvanized coating.

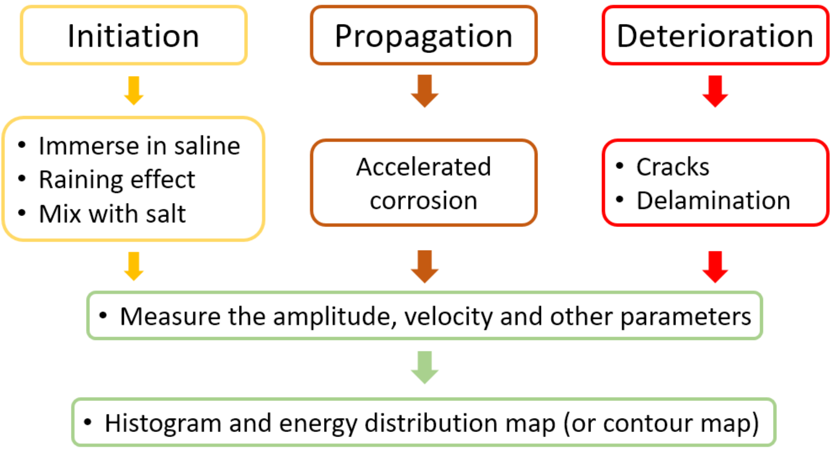
Study on mechanical properties

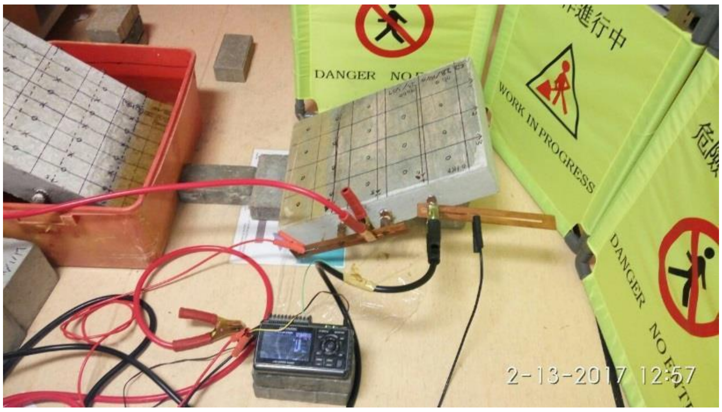
Based on the investigation of the corroded specimens, the corrosion degree and corrosion morphology were found to have important effects on the ductility of the tension steel bars. A series of simulations based on these two factors were conducted by artificial methods aiming to understand the effect of corrosion on the tensile behaviors of the steel reinforcement. The results showed that the ductility of the corroded reinforcement was reduced in an exponential way when the maximum corrosion degree was below 30%, but it stabilized when the corrosion degree was increased further. The geometric property of radius gyration for the residual cross- section was found to be an important factor affecting the ductility of the steel reinforcement. The ultimate strain of the corroded bars could be evaluated by an interpolation method based on the corrosion degree and radius of gyration at the cross-section with maximum corrosion degree.

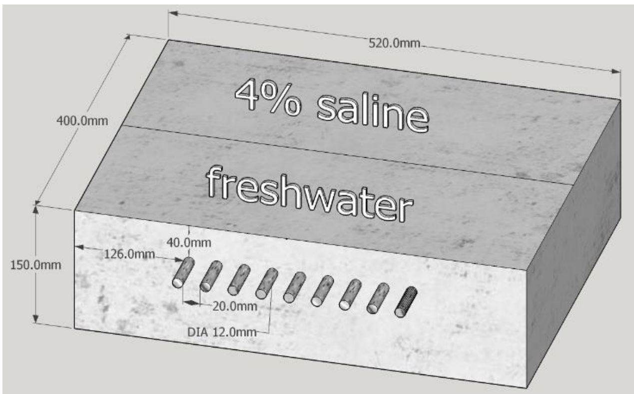
Fig. 2 Image of corroded reinforcement

Fig. 3 Comparison of the failure point for corroded and non-corroded bars

Monitoring of corrosion process by non-destructive testing (radar)







The above experimental programme is in progress. Two journal papers are being prepared.