CALIFORNIA STATE SCIENCE FAIR
2011 PROJECT SUMMARY

Name(s)
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Project Number
S1830

Project Title
Thermoreflectometry for Detecting Corrosion in Steel Reinforced Concrete

Abstract

Objectives/Goals
The objective is to integrate electromagnetic heat induction and infrared (IR) thermograph technology for nondestructive detection of steel corrosion in concrete, by taking advantage of the difference in thermal characteristics of corroded and non-corroded steel.

Methods/Materials
Material for preparing bare and concrete rebar (RC) samples includes cement, sand, aggregate, steel rebar, 3% NaCl solution, and copper plate. The impressed current method was adopted to induce accelerated corrosion on the rebar. The thermoreflectometry consists of an inductive heater to remotely heat the steel rebar from concrete surface, and an IR camera to record IR intensity. Bare rebars and concrete samples with different rebar cover depths were prepared. The inductive heater heated the sample from one surface and the IR thermograph record the image from the opposite side simultaneously.

Results
From the bare rebar test, it is found that the peak IR intensity depends on the rebar corrosion amount; the more corroded rebar exhibits higher peak intensity, and faster heating and cooling rates. From RC sample test, it is observed that the corroded rebar causes higher heat intensity on its surface than the non-corroded rebar, and the heating rate in the corroded sample is also higher than that in the non-corroded sample due to the steel volume loss and the reduced heat capacity of the rebar. For the RC sample with a deeper cover depth, a longer induction heating time is required.

Conclusions/Discussion
From the experiment results, it is confirmed that for a corroded steel rebar, increase in the electrical resistivity and relative permittivity make it easier to be heated by an inductive heater due to the Joule and hysteresis effects. Meanwhile the decrease in the thermal conductivity in the corroded steel rebar results in a slower cooling rate once it is heated. In conclusion, the proposed thermoreflectometry is able to measure the temperatur variation during the heating and cooling process quantitatively. This study demonstrates a potential of the integrated inductive heating and IR thermograph for nondestructive detection of rebar corrosion in concrete.

Summary Statement
Develop a thermoreflectometry for non-destructive detecting of corrosion in steel reinforced concrete

Help Received
Used lab equipment at UC Irvine with helps from lab technical assistants