WIRELESS DETECTION OF CORRISION SALTS IN CONCRETE USING RFID SENSORS

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ABSTRACT

This method can be used for determination of concentration of chlorides in concrete which is responsible for corrosion. For highway infrastructure destructive test for corrosion are taken which leads to traffic congestion and delays with public at risk therefore nondestructive method should be introduced with embedded sensors which determines the concentration of chlorides in concrete. Many of this sensors require power, complex wiring and high costs and there are often difficulties obtaining a clear transduction of the signal from the sensor. Therefore a low cost method can be used for determination of concentration of chlorides in concrete which is responsible for corrosion. For highway infrastructure destructive test for corrosion are taken which leads to traffic congestion and delays with public at risk therefore nondestructive method should be introduced with embedded sensors which determines the concentration of chlorides ingress in concrete.

Keyword- RFID sensor, electrochemical measurement, chlorides, structural capacity, infrastructure

1. INTRODUCTION

Transportation infrastructure, such as bridges and roads, rely on reinforced and prestressed concrete for structural reliability. The penetration of outside chemicals and the subsequent corrosion of reinforcing steel in structural concrete can lower the structural capacity and shorten the service life. The current methodology to determine the health of a concrete structure is time consuming and destructive.

Fig-1: Putting chlorides on top of it when hardened

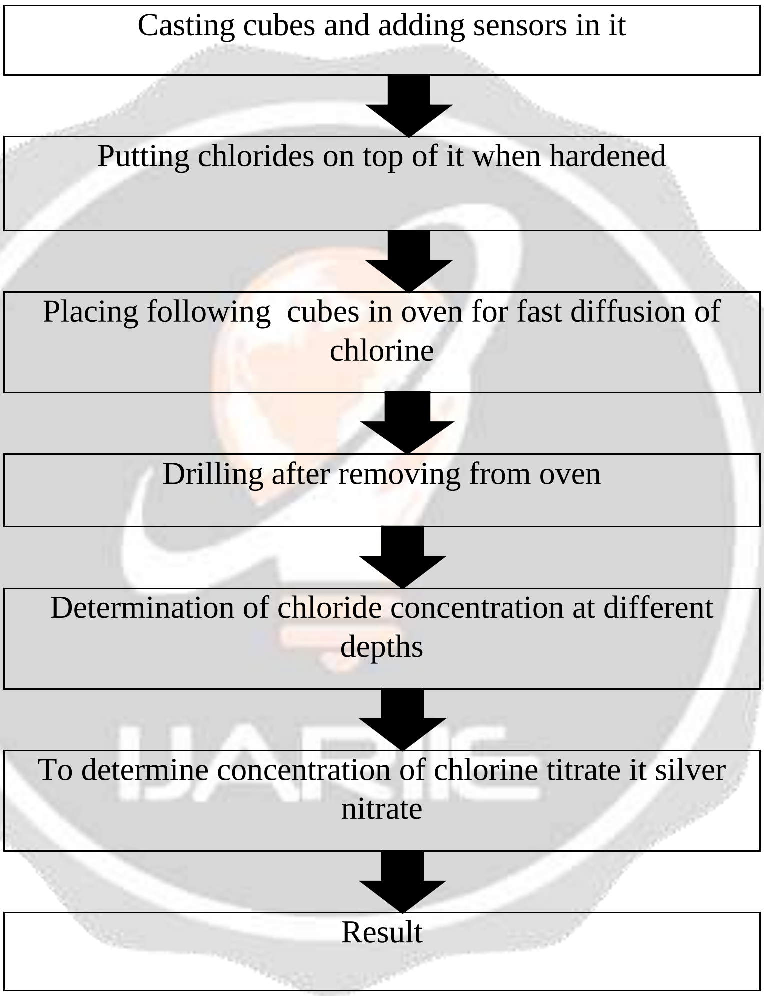
Core samples need to be taken to investigate the chloride content of concrete and at surface of the reinforcing steel. In addition to being potentially damaging to the structure, this work requires lane closures, causes traffic delays, and puts maintenance crews and the traveling public at risk.The annual direct cost corrosion to structural concrete in bridges and overpasses has been estimated about$8.3 billion .A noninvasive method to monitor the potential for corrosion in reinforced and prestressed concrete will be extremely beneficial. Others have developed sensors based on fiber optics, electrochemical measurement, and many other techniques.Many of these sensors require power, complex wiring, and high costs, and there are often difficulties obtaining a clear transduction of the signal from the sensor. More directly related are upowered binary sensors based on a radio frequency resonance phenomenon. These sensors, utilize the corrosion of a surrogate wire. However, the analog nature of these devices coupled with the difficulty of measuring the frequency response of a device whose quality factor in the resonance circuit changes with corrosion makes data interpretation problematic. These limitations have hindered the widespread use of corrosion sensors in current infrastructure. If an economical sensor could be developed that provides a clear indication of the potential for corrosion in a structure without the use of wires and internal batteries, it would have an excellent chance for widespread implementation.

Fig-2: Placing following cube in oven for fast diffusion of chlorine

Fig-3: Casting Cubes and providing sensors

2. METHEDOLOGY

A standard RFID tag, consisting of a RFID device or integrated circuit, a capacitor, and a receiver coil, is inexpensive, wireless, and requires no internal power. The prototype sensor was constructed using a commercial RFID tag by replacing a section of the receiver coil, which is wrapped around the parameter of the device, with either a 0.125- or 0.065-mm diameter iron trigger wire. After modification, the tags responded to the RFID reader and were embedded very close to the surface of the concrete. First of all we have to take a plastic container of about 750 ml after that we have to pour concrete in it till a certain level above the rebar at that level we have to embed our RFID (radio frequency identification technology) sensor into it Such that we can obtain a clear transduction from our sensor. After that we have to pour concrete upon it that is your clear cover After that we have to add 5 percent sodium chloride solution above the cube and keep it in a dessicator for 2 days such that the sodium chloride inside it gets penetrated.



Once we don't get any signal from the sensor we can predict that the sodium chloride has reached the sensor and the wires have been corroded To check weather the wires are corroded we have to drill the cube at various depths to check the amount of sodium chloride at each depth as the sodium chloride is in powdered form we have to titrate it against silver.nitrate to check the amount of sodium chloride in it By this we can predict the amount of sodium chloride which was required to corrode the wire Once corrosion testing was stopped, the container was removed, the sodium chloride solution was washed off with water, and the sample was allowed to dry for a day. After drying, powder samples were taken from the concrete samples at 1-mm depths by drilling into the sample with a diamond-coated drill bit. For concrete with embedded wires, the powder samples were taken after wire failure to quantify the chloride concentration at the trigger time. For the prototype corrosion sensor, the samples were taken after the sensing wire corroded and the RFID circuitry failed to respond to a reader. To determine the chloride concentration, each powder sample at a given depth was titrated with a standardized silver nitrate solution

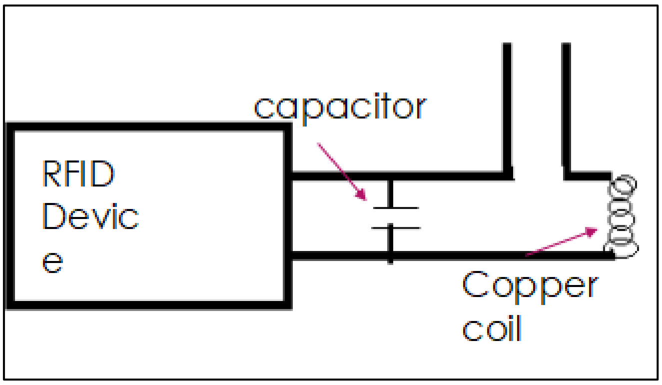


Fig-5 : Block diagram of the RFID-based corrosion sensor

2.1 Applications of These Sensors

These results clearly show that mild steel trigger wires can be used to monitor the ingress of corrosive agents into concrete and that a RFID tag can be used to passively and wirelessly indicate the ingress of chlorides into concrete. These sensors do not monitor the depassivation or rate of corrosion of reinforcing steel. Instead, they indicate the concentration of chloride salts in the concrete at the depth of the sensors. The sensors may trigger at different chloride concentrations for different concrete mixtures. If exact trigger values are needed for a specific application, these sensors should be calibrated using the specific materials used in the application. However, even without specific testing, these sensors provide a useful tool for owners to monitor the ingress of corrosive agents. This information can be used to predict the future deterioration of their structures from chlorides. This can allow owners to change the ways deicing salts are applied to their structure, provide guidance about the type and location of protective coatings, and allow for accurate service-life predictions to be made while minimizing assumptions. By providing this information, owners can plan and budget for future repairs and ensure that their infrastructure performs satisfactorily. Sensors similar to those presented in this paper have been installed in four bridges in Oklahoma. Future publications will cover the sensor usage and adoption to measure the health of structures.

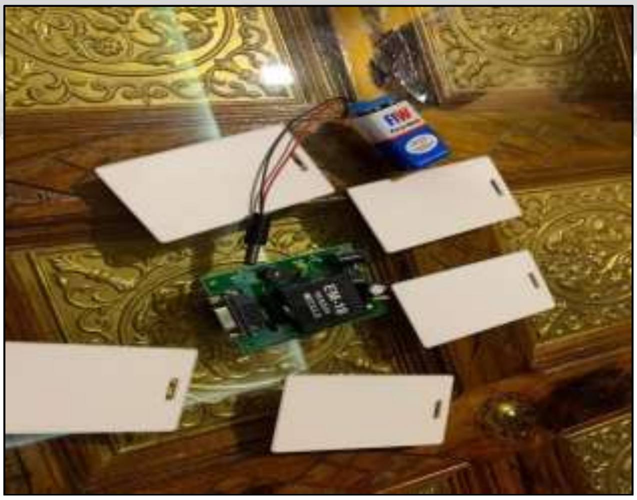


Fig-4:RC522 RFID Sensor Module Card Reader writer module 12C IIC interface IC Card RF Sensor Module Ultra Small RC522 13.56 MHz

3. RESULTS

The results from the mild steel coupon tests are shown in Figure. The mass loss versus time is linear. Experiments using rebar resulted in a rate of corrosion mass loss. Thus, the corrosion rates for rebar and mild steels are very similar. Three replicates of each material at each data point were performed. This result supports the decision to use commercially available mild steel wire to monitor the for the trigger, 99.99% pure iron wires were utilized due to the availability of various wire diameters. Chemically, this material is very similar to the mild steel, which has an iron content ranging from 98.81 to 99.26%. Fig. shows the failure time for iron wires of various diameters in 5% sodium chloride solution for at least 8 replicate samples at each data point. For wires with diameters smaller than approximately 0.12 mm, there is very little difference in the time it takes to trigger due to corrosion. The correlation between time and the amount of corrosion provides important input into the design of corrosion sensors using iron wires as the sensing or trigger link. Using these data, 0.065- and 0.125-mm diameter wires were selected as the triggering link for the next experiments.

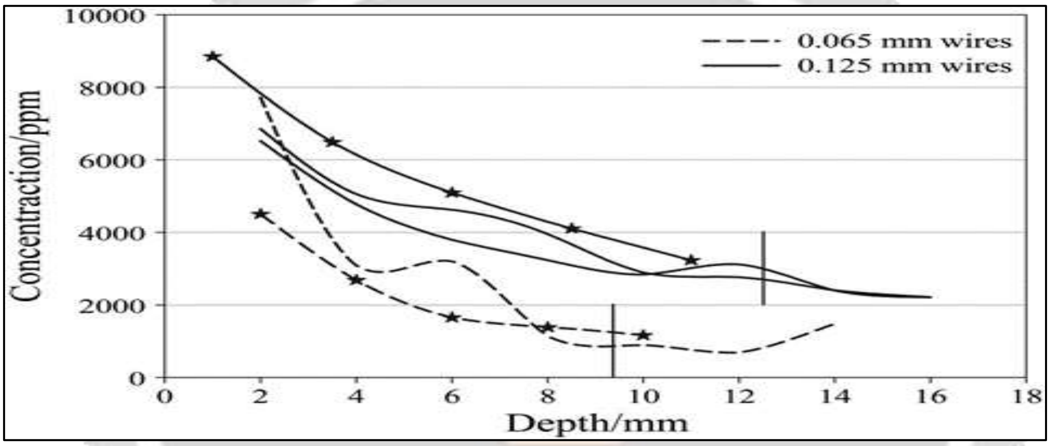


Fig -6: Chloride diffusion profile for concrete sample with embedded wires; solid lines are for samples that contain 0.125-mm wires, while dashed lines are for theses that contain 0.065-mm wires; lines with star markers are samples containing the RFID prototype sensors; vertical lines show embedment depth of the RFID prototype sensors in concrete

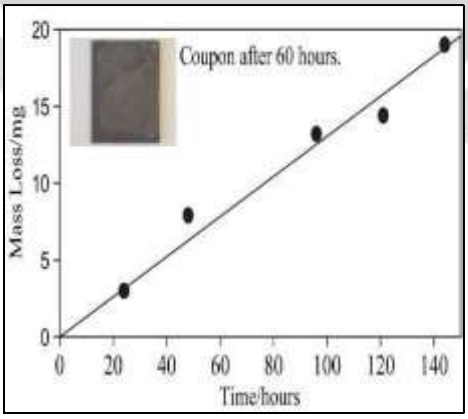


Fig -7: Weight loss versus time for mild steel in a 5% sodium chloride solution; the slope is the weight loss per hour for a 6.5-cm2 coupon,

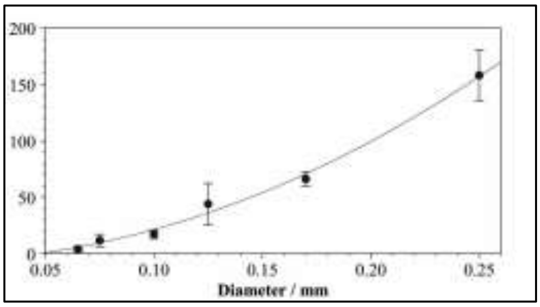


Fig- 8: Trigger times as a function of wire diameter in a 5% NaCl solution.

4. CONCLUSION

To determine the chlorine concentration in concrete with the help of wireless sensors. The objective of this technology is to prevent corrosion of the reinforcement with the use of RFID detectors which are very cheap and effective. Many of this sensors require power, complex wiring and high cost and there are often difficulties in obtaining a clear transduction of the signal from the sensors. Therefor a low cost method can be used for determination of concentration of chlorides in concrete which is responsible for corrosion. For highway infrastructure destructive test for corrosion are taken which leads to traffic congestion and delays with public at risk therefore non destructive method should be introduced with embedded sensors which determines the concentrations of chlorides ingress in concrete.

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6. REFERENCES

1. A magnetic sensing approach to characterize corrosion in reinforced concrete.” Proc. SPIE Int. Soc. Opt. Eng., 6529(1), 65291A/65291–
2. Dantan, N., and Habel, W. R. (2006). “Monitoring of corrosion protection. A concrete-embeddable pH optode.” Betonwerk Fertigteil-Tech., 72(3),48–50, 52–55.
3. Lu, S., and Ba, H.-J. (2010). “Corrosion sensor for monitoring the service condition of chloridecontaminated cement mortar.” Sensors, 10(4), 4145– 415
4. Lu, S., and Ba, H.-J. (2010). “Corrosion sensor for monitoring the service condition of chloridecontaminated cement mortar.” Sensors, 10(4), 4145– 415
Short, N. R., Page, C. L., and Glass, G. K. (1994).“Design and operation of a galvanic sensor for inservice monitoring of the corrosion of steel in concrete.” Proc. SPIE Int. Soc. Opt. Eng.
5. Lu, S., and Ba, H.-J. (2010). “Corrosion sensor for monitoring the service condition of chloridecontaminated cement mortar.” Sensors, 10(4),4145– 4158.
6. Wireless low-cost corrosion sensors for rein_x005F_x0002_forced concrete structures.” Proc. SPIE Int. Soc. Opt. Eng., 5765(1), Tamura, H., Nagayama, M., and Shimozawa, K. (1996). “Rebar corrosion monitoring using embedded minisensors.” Spec. Publ.—R. Soc. Chem.,183, 294–302
7. Tamura, H., Nagayama, M., and Shimozawa, K. (1996). “Rebar corrosion monitoring using embedded minisensors.” Spec. Publ.—R. Soc. Chem.,183, 294–302[3].Park, Z.-T., Choi, Y.-S., Kim, J.-G., and Chung, L. (2005).