

Supporting Information

Figure S1. A corrosion sensor and the sensor system installed on a steel bridge over Mississippi River.

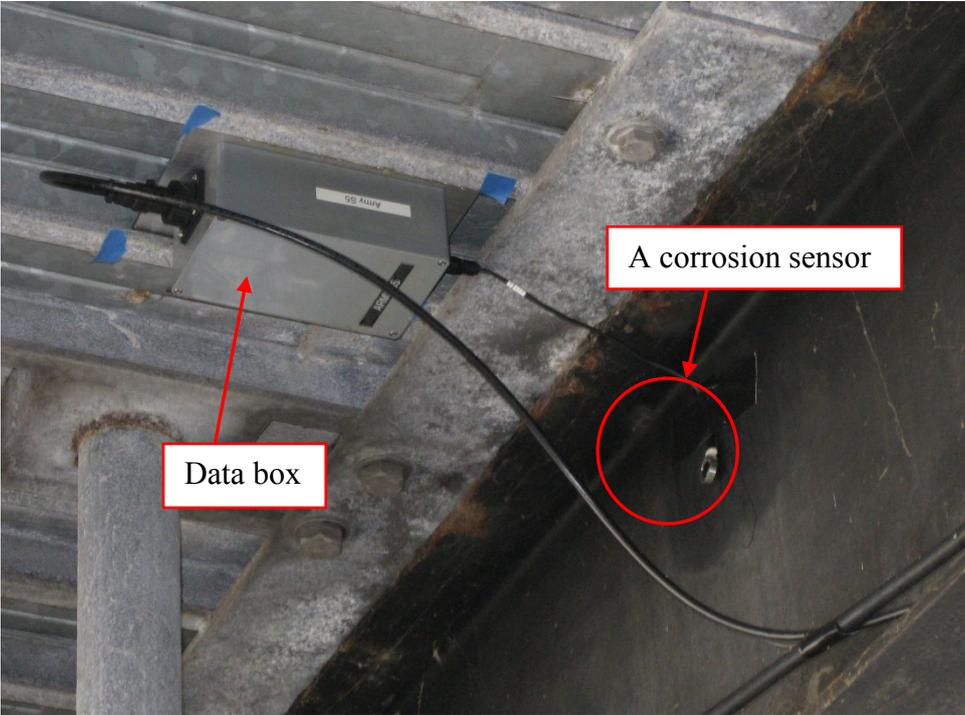
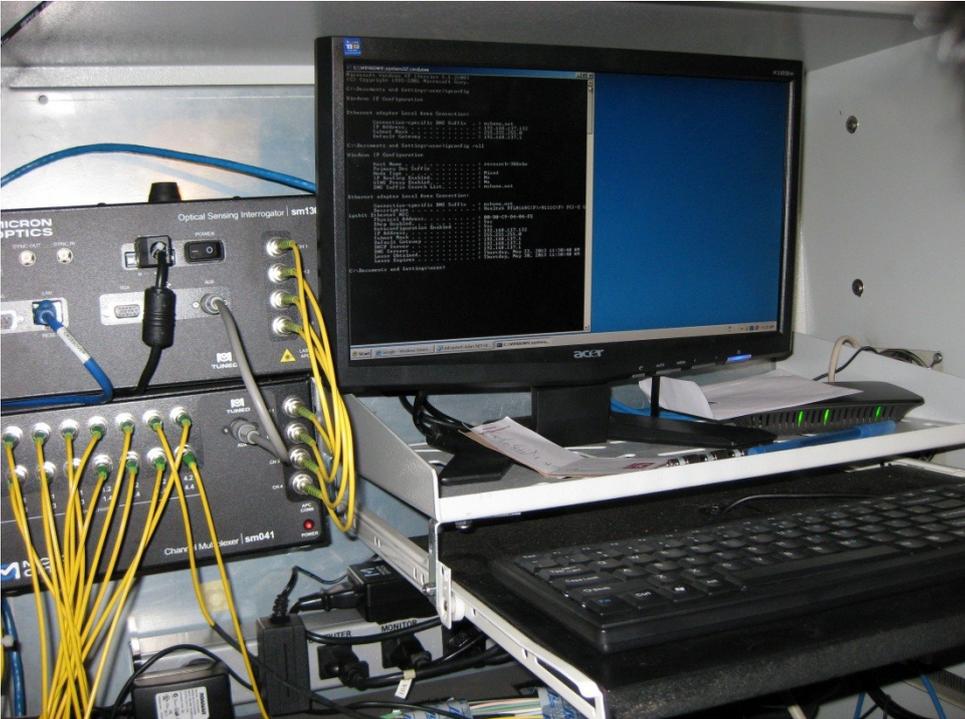


Figure S2. The corrosion data acquisition and monitoring system.



When fringe field is considered, Heerens [1] proposed the following equation to calculate the approximate value of capacitance.

$$C = \frac{4\varepsilon_0\varepsilon(b-a)}{\pi} \sum_{n=1}^{\infty} (-1)^n [1 - \cos(nz)]^2 [n^2 W_n(r_1, r_2)]^{-1} \quad (S1)$$

where C = sensor's capacitance (pF); ε = dielectric constant of the material(s) between the A36 steel rod and the 316 stainless steel ring; a = radius of the A36 steel rod (m); b = inner radius of the 316 stainless steel ring (m); h = height of the cylinder sensor (m); $z = \pi h/(b-a)$; $r_1 = \pi a/(b-a)$; $r_2 = \pi b/(b-a)$.

$W_n(r_1, r_2) = I_0(nr_1)K_0(nr_2) - K_0(nr_1)I_0(nr_2)$, in which $I_0(u)$ and $K_0(u)$ are the modified Bessel functions of the first and second kind and of zero order which for an argument u , respectively.

Similar to Equation (13) in the paper, a much more complicated equation of multi-material capacitance in-series with considering fringing effect can be derived. In agreement with Equation (13), the capacitance with fringe effect shows that the capacitance change is more sensitive to ε , the dielectric constant of the material(s) (*i.e.*, rust and air) between the A36 steel rod and the 316 stainless steel ring than the change of a , the radius of the A36 steel rod.

Reference

1. Heerens, W.C. Application of capacitance techniques in sensor design. *J. Phys. E: Sci. Instrum.* **1986**, *19*, 897–906.