Ultrasonic Pulse Velocity Method for Corrosion Detection of Carbon Steel

C. G. Chockalingam[1] and C. Vipulanandan[1], Ph.D., P.E.
[1]Center for Innovative Grouting Material and Technology (CIGMAT)
Department of Civil and Environmental Engineering
University of Houston, Houston, Texas 77204-4003
E-mail: chella.ganapathy92@gmail.com, cvipulanandan@uh.edu Phone: (713) 743-4278

Abstract
In this study, the corrosion of A1018 low carbon steel specimen was immersed in 51 % of sulfuric acid solution (pH = -1.28) under room condition for 3 hours and the ultrasonic pulse velocity method was used to characterize the changes.

1. Introduction

Steel, the most commonly used metal, corrode in many media including sodium chloride environment. Usually they are selected not for their corrosion resistance but for such properties as strength, ease of fabrication, and cost. These differences show up in the rate of metal lost due to rusting (Roberge, 1999).

2. Objective

Investigate the potential of using ultrasonic pulse velocity to detect and quantify corrosion and compare it with weight change in the steel due to corrosion.

3. Materials and method

As testing specimen, ASTM 1018 low carbon plate sample with dimension of about 764 mm×31 mm×4.3 mm were used for this experiment. Specimen was placed in 51 % sulfuric acid solution for 3 hours and was exposed to air for 1 day. The ultrasonic device (with compression transducers) with the frequency of 150 kHz has been used to study the corrosion.

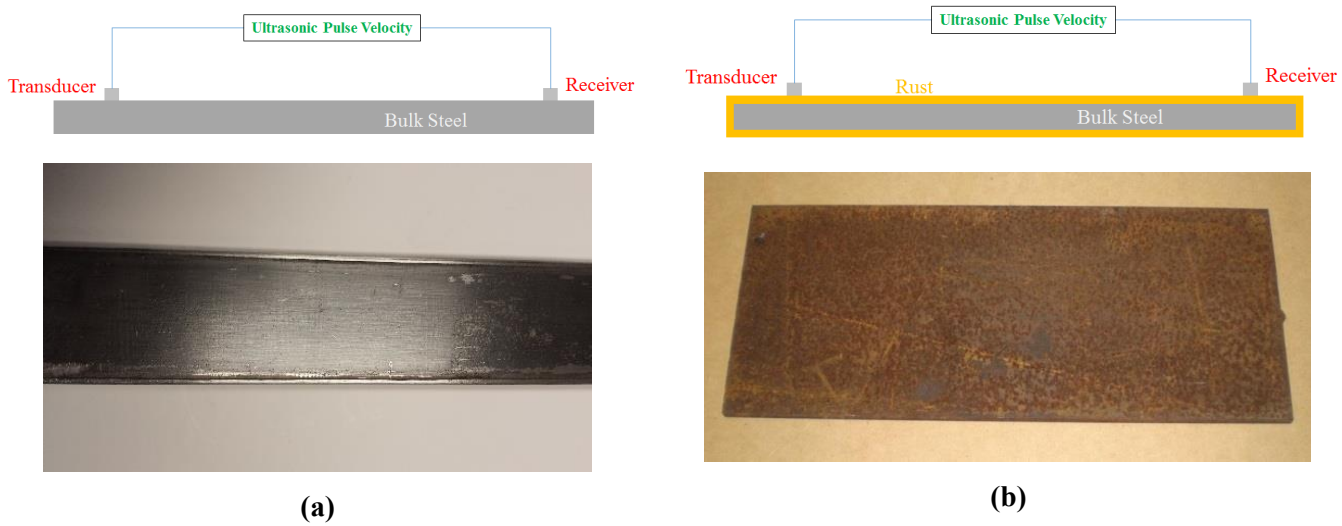

Figure 1. Schematic setup of (a) Non – Corroded steel and (b) Corroded steel

4. Results and Analyses

Ultrasonic pulse velocity measurement was taken for the uncorroded and corroded steel for different lengths. As rust formation happens in steel, the time travel for the compression wave to propagate increases, due to the formation of oxide layer. From Figure 2, pulse velocity of corroded steel is less than uncorroded steel for different lengths of measurement.

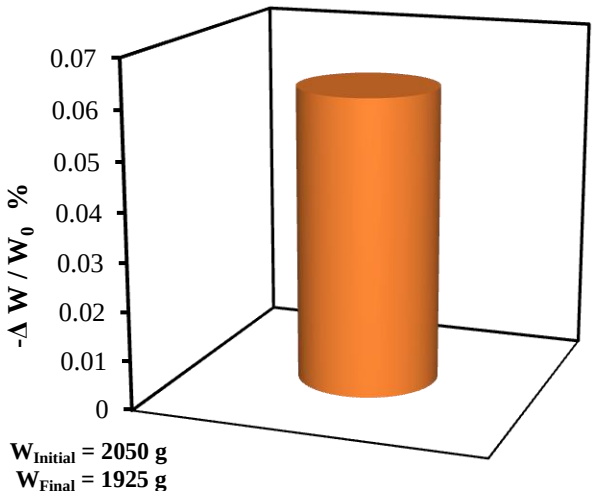

Figure 2. Time for wave propagation Vs Distance

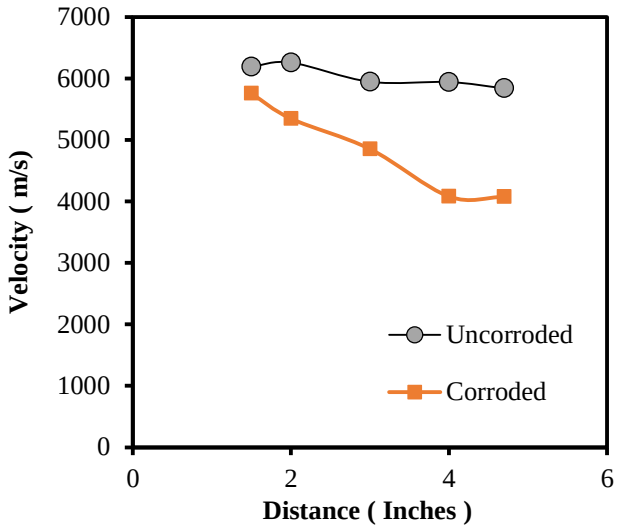

Figure 3. Velocity of wave propagation Vs Distance

5. Conclusion

The corrosion of low Carbon A1018 steel was detected using ultrasonic pulse velocity and this method was found more effective and sensing than regular corrosion rate measurement using weight loss and dimensional change.

6. Acknowledge

This study was supported by the Center for Innovative Grouting Materials and Technology (CIGMAT) and Texas Hurricane Center for Innovative Technology (THC-IT), University of Houston, Houston with funding from DOE/NETL/RPSEA (Project 10121-4501-01).

7. References

1. Roberge PR., “Handbook of Corrosion Engineering”. New York: McGraw-. Hill, 1 P, 1999.

2. Vipulanandan, C., and Garas, V. (2008) "Electrical Resistivity, Pulse Velocity and Compressive Properties of Carbon Fiber Reinforced Cement Mortar,” *Journal of Materials in Civil Engineering*, Vol. 20, No. 2 , pp. 93-101.