“On the Use of Ground Penetrating Radar to Detect Rebar Corrosion in Concrete Structures”

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We continue our investigations into the use of ground penetrating radar (GPR) to detect and quantify corrosion-induced metal loss in reinforcing bars (rebar) embedded in concrete structures. Past experimental work in 2012 on a highway bridge in central Iowa [1] suggested that GPR could be used to differentiate an intact rebar from one having substantial metal loss due to corrosion. That study made use of the amplitudes of GPR signals reflected by rebar, as obtained using a commercial instrument operated in pulse/echo mode. There it was assumed that a rebar containing a thinned region (i.e., presenting a smaller metal target to the incoming microwave pulse) would reflect more weakly than an un-thinned rebar, thus resulting in a GPR signal having a smaller peak amplitude. Several rebar having abnormally small peak amplitudes were detected in the course of the highway bridge inspection.

Two new studies are summarized in this presentation. In the first, we compare recent GPR measurements on the same bridge to those obtained in 2012. The newer measurements use both the 1.6 GHz antenna used in the earlier work and an alternative higher frequency antenna (2.6 GHz). We discuss similarities and differences between the old and new results at 1.6 GHz, and also summarize the effect of the frequency change on the newer measurements.

Many factors can contribute to the strength of the GPR echo seen from a given rebar, including the rebar’s length, its distance from and tilt angle relative to the antenna, and the location and size of the metal-loss region. In the second section of the presentation we discuss new laboratory measurements to systematically investigate these geometric effects. In 2016 we studied such effects using a simplified measurement setup where only an air layer separated the antenna from the rebar [2]. Here we discuss similar measurements simulating rebar embedded in concrete. For our concrete “phantom” we use a layer of moist sand in between two parallel concrete blocks. When the moisture content is properly chosen, the EM properties of sand are similar to those of cured concrete. The block/sand/block sandwich then serves as a concrete-like medium in which a rebar can be inserted and readily repositioned. Results of GPR measurements using this new sandwich approach are reported and compared with those of the earlier “air layer only” measurements.

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[1] David Eisenmann, Frank Margetan, Thomas Chiou, Ron Roberts, and Scott Wendt, “Ground Penetrating Radar Applied To Rebar Corrosion Inspection”, Rev. of Prog. in QNDE, Vol. 32, eds. D.O. Thompson and D.E. Chimenti, (AIP, Melville NY, 2013), pp. 1341-1348.

[2] David Eisenmann, Frank J. Margetan, C.-P. Chiou, Shelby Ellis, Tongge Huang, and Jern Yang Tan, “Effects of position, orientation, and metal loss on GPR signals from structural rebar”, AIP Conference Proceedings 1806, 080005 (2017)