Geometric Analysis of Ground Penetrating Radar Signals for Condition Assessment

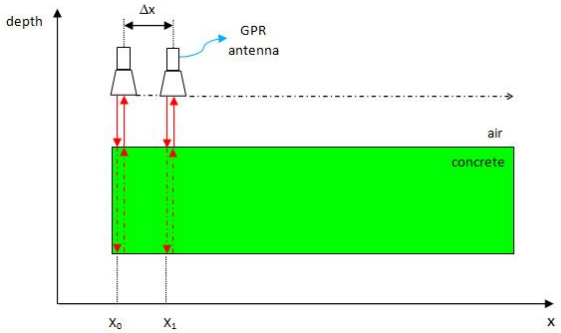
- **Abstract:** Detection and characterization of damages in civil structures is vital for public safety. Microwave/radar techniques are suitable for in-depth assessment of concrete structures since electromagnetic waves can penetrate into dielectric materials like concrete. Ground penetrating radar (GPR) is one of the widely-used techniques for concrete structures. In this research, Finite Difference Time Domain (FDTD) methods were used to study the scattering pattern of a delamination defect in a concrete slab.

- **Theoretical background:** Radar signals or microwaves are governed by the laws of electricity and magnetism which can be described by Maxwell's equations.

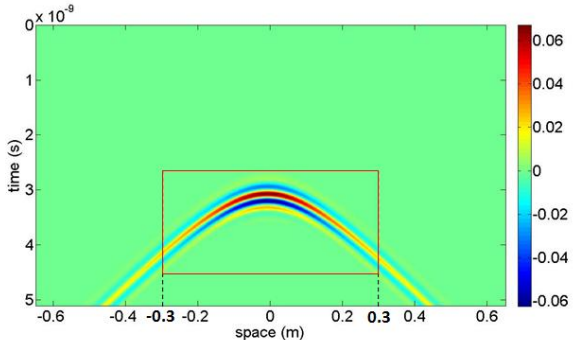
$$\nabla \times \bar{H} = \frac{\partial}{\partial t}\bar{D} \qquad \nabla \cdot \bar{D} = 0$$

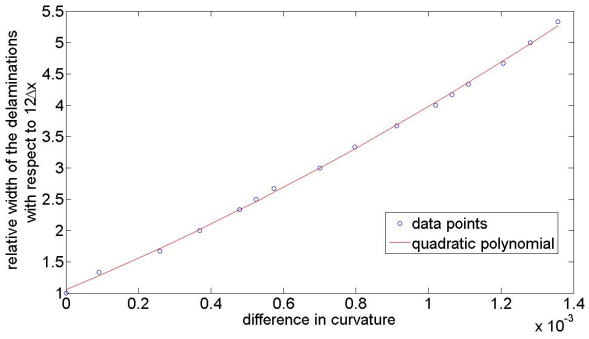
$$\nabla \times \bar{E} = -\frac{\partial}{\partial t}\bar{B} \qquad \nabla \cdot \bar{B} = 0$$

- **Analysis:** A bistatic radar inspection was considered and used to generate B-scan images for analysis.



- **Results:** Windowed B-scan images were processed and converted into parabolas for pattern recognition. A quadratic equation was developed between the delamination size w and the curvature difference $\Delta\rho$.





$$w = 3.72\times10^{8}\Delta\rho^{3} - 2.55\times10^{5}\Delta\rho^{2} + 2{,}825\Delta\rho + 1.013$$

- **Conclusion:** The curvature of the parabola, arch-like shapes obtained from B-scan images of concrete slabs shows a close relationship with the size of delamination are related. Finally, a procedure for estimating the size of subsurface delamination in concrete slabs is proposed.

Burak Boyaci

- **Ref:**

- **Boyaci**, B., Master's Thesis, Dept. of Civil & Envir. Eng, UMass Lowell, June, 2010.
- Yu and **Boyaci**, *SPIE Conf.*, Vol. 7983, 2011.

[Research sponsor: National Institute of Standards and Technology (NIST) Technology Innovation Program (TIP), 2009~2014] (Contact Prof. Yu at tzuyang_yu@UML.EDU)