

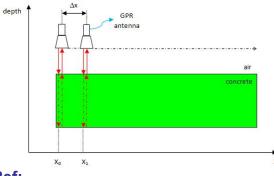
## Geometric Analysis of Ground Penetrating Radar Signals for Condition Assessment



- 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.

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

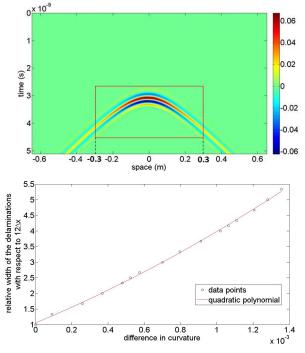
• **Analysis:** A bistatic radar inspection was considered and used to generate B-scan images for analysis.



## • Ref:

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

• **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  $\Delta \rho$ .



 $w = 3.72 \times 10^8 \Delta \rho^3 - 2.55 \times 10^5 \Delta \rho^2 + 2,825 \Delta \rho + 1.013$ 

**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.



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