Simulated Transient Electromagnetic Response of GFRP-Wrapped Concrete Cylinders using Radar NDE

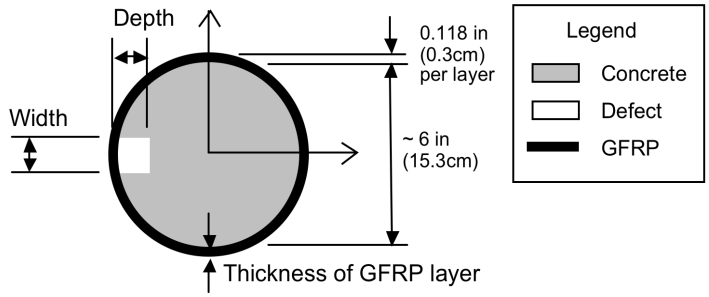
- **Abstract:** Assessing the subsurface condition of glass fiber reinforced polymer (GFRP)-retrofitted concrete structures is an important inspection problem for the maintenance of reinforced concrete structures retrofitted with high performance composites like GFRP. The objective of this research is to investigate the radar response of GFRP-concrete cylinders through a parametric study, using the finite difference time domain (FDTD) method. Intact and artificially damaged GFRP-wrapped concrete cylinders were modeled in a two dimensional domain. Considered parameters included the thickness of GFRP wrap/layer, width and depth of artificial defects, and incident frequency. Modulated Gaussian signals with a carrier frequency ranging from 8GHz to 18GHz were used as the incident wave. Field and power responses in both time and frequency domains were investigated.

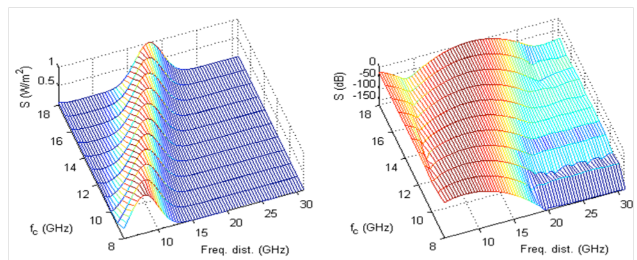
- **Theoretical background:** Radar signals or microwaves are governed by the laws of electricity and magnetism which can be described by Maxwell's equations.

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

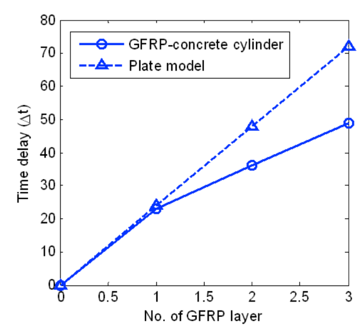
$$\nabla \times \bar{E} = -\frac{\partial}{\partial t}\bar{B} \qquad \nabla \cdot \bar{B} = 0$$

- **Results:** Both field and power responses were investigated.





(a) Poynting power density, S (W/m^2) (b) S in decibel (dB)



- **Conclusion:** i) A nonlinear effect due to the variation of defect dimensions is found in both time and frequency responses, indicating the multiple, interlayer scattering effect in the system. ii) Proportionality is observed in the maximum power density difference extracted from intact and damaged concrete cylinders with various depth configurations

- **Ref:** Yu, *et al.* RNDE, 24:125-153, 2013.

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