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Non-Destructive Evaluation of Concrete Using GPR: Analysis Based on Direct Wave Amplitude

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Introduction

Ground Penetrating Radar (GPR) is widely employed for the non-destructive evaluation (NDE) of concrete structures due to its high resolution, portability, and efficiency. This study introduces a simplified GPR-based methodology to assess concrete condition by analyzing the amplitude of the direct wave—namely, the early air-coupled signal received before subsurface reflections. The objective is to determine whether this amplitude can serve as a qualitative indicator of concrete integrity. By avoiding full waveform inversion and dielectric property estimation, the method aims to support rapid, low-complexity assessments in engineering and geophysical applications.

Method

GPR measurements were conducted on concrete samples with controlled variations in internal composition and moisture content. A 1600 MHz antenna was employed to ensure sufficient resolution for near-surface evaluation. The amplitude of the direct wave was extracted from radargrams and analyzed comparatively across samples. The approach emphasizes relative amplitude variation as a proxy for differences in compaction, porosity, and moisture—parameters known to influence electromagnetic wave propagation—while avoiding computationally intensive modelling.

Results and Conclusions

Preliminary findings reveal a qualitative relationship between direct wave amplitude and internal concrete properties. Samples with higher compaction and lower porosity displayed stronger amplitudes, while increased moisture or heterogeneity resulted in attenuated responses. Although the method does not yield quantitative estimates of dielectric parameters, it provides a practical and efficient screening tool for initial assessments. The approach may complement advanced GPR analyses in infrastructure inspection and geotechnical diagnostics. Future work will focus on field validation and the integration of machine learning techniques for automated data interpretation.