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An effective approach for road asset management through the FDTD simulation of the GPR signal

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Ground-penetrating radar is a non-destructive tool widely used in many fields of application including pavement engineering surveys. Over the last decade, the need for further breakthroughs capable to assist end-users and practitioners as decision-support systems in more effective road asset management is increasing. In more details and despite the high potential and the consolidated results obtained over years by this non-destructive tool, pavement distress manuals are still based on visual inspections, so that only the effects and not the causes of faults are generally taken into account. In this framework, the use of simulation can represent an effective solution for supporting engineers and decision-makers in understanding the deep responses of both revealed and unrevealed damages. In this study, the potential of using finite-difference time-domain simulation of the ground-penetrating radar signal is analyzed by simulating several types of flexible pavement at different center frequencies of investigation typically used for road surveys. For these purposes, the numerical simulator GprMax2D, implementing the finite-difference time-domain method, was used, proving to be a highly effective tool for detecting road faults. In more details, comparisons with simplified undisturbed modelled pavement sections were carried out showing promising agreements with theoretical expectations, and good chances for detecting the shape of damages are demonstrated. Therefore, electromagnetic modelling has proved to represent a valuable support system in diagnosing the causes of damages, even for early or unrevealed faults. Further perspectives of this research will be focused on the modelling of more complex scenarios capable to represent more accurately the real boundary conditions of road cross-sections.

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