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Ground penetrating radar data analyzed in frequency and time domain for engineering issues

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Non-destructive testing (NDT) allows to analyze reinforced concrete and masonry structures, in order to identify gaps, defects, delaminations, and fracture. In the field of engineering, non-invasive diagnostic is used to test the processes of construction and maintenance of buildings and artifacts of the individual components, to reduce analysis time and costs of intervention (Proto et al., 2010). Ground penetrating radar (GPR) allows to evaluate with a good effectiveness the state of conservation of engineering construction (Mellet 1995)). But there are some uncertainties in GPR data due to the complexity of artificial objects. In this work we try to evaluate the capability of GPR for the characterization of building structures in the laboratory and in-situ. In particular the focus of this research consists in integrate spectral analysis to time domain data to enhance information obtained in a classical GPR processing approach. For this reason we have applied spectral analysis to localize and characterize the presence of extraneous bodies located in a test site rebuilt in laboratory to simulate a part of a typical concrete road. The test site is a segment of a road superimposed on two different layers of sand and gravel of varying thickness inside which were introduced steel rebar, PVC and aluminium pipes. This structure has also been cracked in a predetermined area and hidden internal fractures were investigated. The GPR has allowed to characterize the panel in a non-invasive mode and radargrams were acquired using two-dimensional and three-dimensional models from data obtained with the use of 400, 900, 1500 and 2000 Mhz antennas. We have also studied with 2 GHz antenna a beam of ‘to years precast bridge characterized by a high state of decay. The last case study consisted in the characterization of a radiant floor analyzed with an integrated use of GPR and infrared thermography.
In the frequency domain analysis has been possible to determine variations in the spectrum that allows a supplementary help to complete the information extracted in time-domain (dos Santos et al., 2014). The signal processing technique is based on a Fast Fourier Transform (FFT) that allows analyzing in frequency domain variations due to presence of anomalous bodies of different materials in the concrete and in the sand. Furthermore the data obtained in situ are compared with data extracted by theoretical simulation of e-m signal propagation built in Reflex-w software. There is a good agreement between simulated data and real data both in frequency domain both in time domain. So we have verified that frequency analysis can be adopted such as a useful tools to increase and complete information achieved in traditional way.

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