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Detecting bridge deck defects with high resolution ground penetrating radar

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The use of electromagnetic waves for detecting objects within materials, was theorized in the early twentieth century in a German patent by Leimbach et Löwy, but a renewed interest in the modern era arose during the Vietnam war when American forces experimented with it to detect tunnels dug by the Viet Cong.
Applications of GPR to Structures started to grow in the 1980s; amongst these, initial civil engineering applications included condition assessment of highway pavements and their foundations, with applications to structural concrete focusing on inspection of bridge decks.
There are many factors that can cause or contribute to the damage of the top layer of concrete in bridge decks including the corrosion of steel rebar, freeze and thaw cycles, traffic loading, initial damage resulting from poor design and/or construction, and inadequate maintenance.
When applied to the analysis of bridge decks, Ground Penetrating Radar (GPR) can be successfully used for detecting internal corrosion of steel reinforcement within the concrete deck, which can be an indicator of poor quality overlay bonding or delamination at the rebar level.
Therefore, this equipment has the ability to gain information about the condition of bridge decks in a more rapid and less costly fashion than coring and perhaps will yield more reliable assessment than current geotechnical procedures.
However, a suitable design of the equipment being used in this application is required; for instance, optimization of antenna orientation to take advantage of signal polarization, is an important feature in successful location of reinforcing bars in time-depth slice.
IDS Ingegneria dei Sistemi has recently developed and released a tool dedicated to the non destructive analysis of bridge decks; the RIS Hi-Bright introduces a new approach in radar survey, increasing the resolution thanks to a very dense data collection and, at the same time, reducing the time necessary to perform the collection.
The system integrates two arrays of very high frequency antennas, one in parallel polarization with respect to the forward direction (VV), one in orthogonal polarization with respect to the forward direction (HH); in this way, the equipment is capable of collecting 16 profiles, 10 cm spaced in a single swath, thus collecting an incredible amount of information.
A dedicated data analysis software provides a 2-D tomography of the underground layers and a 3-D view of the surveyed volume. Main output include the determination of pavement and concrete thickness, the detection of moist areas as well as concrete damages and the location of rebars and ducts within the concrete slab.
Full length paper will include some case studies.